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Concrete

Vol. 8 *Detroit, January, 1916* *No. 1*

The Concrete House is Practical

SOME time ago this magazine was asked whether or not in its estimation concrete houses, after concrete roads, are likely to consume the largest amount of cement. The progress of the field seems to indicate that the concrete house presents the greatest *possibility,* but not the greatest immediate prospect.

The concrete house is not a big immediate prospect in the field because architects are, in the main, thinking in terms of other materials and do not design concrete houses economically. The concrete house is not a big immediate prospect because only a few builders have studied the special construction problems and applied economical methods to such work.

The concrete house has great possibilities because with known methods, the concrete house, large or small, *can* compete in cost with other structural materials, value for value, and while concrete properly erected does not suffer by comparison in appearance and while concrete possesses advantages in permanence, insulation, ability to use local material and in fire protection, which are denied competing materials, still, in spite of this, the *CAN* in this possibility comprehends vastly more knowledge among architects and builders of concrete and how it should be handled. They have wrestled with the problems of big building construction and in large measure solved them. There are big rewards for builders who will so wrestle with the problems of house construction.

The one great foe of the concrete house is ignorance—ignorance on the part of the architect, who is often slow to suggest new methods to his clients and often mentally lazy, in that he will not make the effort necessary to acquire the working knowledge with which to design economically in concrete and to co-operate with the builder to secure proper construction methods, and ignorance on the part of the builder, who prefers to follow a rut and places a prohibitive price on concrete house construction when asked to figure; instead of investigating the avenues of possibilities opened in this new field and welcoming a chance to show what can be done at reasonable cost by modern methods. Lastly, there is the ignorance of the worker, he who handles the tools, and who seldom shows a desire to embrace new methods which would eventually lead to his own advancement.

It is hoped that the variety of methods and of houses presented in this magazine will serve as an inspiration and a spur to greater efforts.

A Slogan For a House-Building Specialist

GETTING a fireproof house for permanence and comfort at a cost little or no more than the cost of inflammable construction which requires continuous expenditure for upkeep depends chiefly upon the ingenuity of architect and builder. There are accounts in this magazine of the exercise of such ingenuity. *Common knowledge* of the methods by which low-cost concrete houses are produced does not exist in the sense that there is a great deal of common knowledge of carpentry and masonry methods. Ingenious individual builders —frequently building houses for themselves in dull seasons—are gradually adding to the store of knowledge.

A builder might well specialize in concrete houses. He would have to be close to the architect designing the house. The two could, by a little foresight—a little thinking in the terms of concrete—do a great deal to encourage fireproof home-building.

It would seem that having done two or three attractive, moderate-priced houses a builder could, by seeing to it that his name was associated with the idea of good service—work well done—an eye to the owner's interest and all the other things that are understood by the term good service, build up a specialist's business in a line on which his name—by advertising—would signify something. A builder who followed such a course should not fail to have his name permanently and continuously associated with his work. Let that name stand so unmistakably for a certain kind of work, that *work* and *name* become associated. The foundation for such a plan of campaign is in a few jobs particularly well done—a few satisfied owners. Let the public learn such a slogan as this: *"Smith-Built* Concrete Houses—for Permanence."

Composition Flooring

ELSEWHERE in this magazine will be found a discussion of magnesite or "composition" floors.

It is believed that many readers will welcome an impartial discussion of this subject. Composition floors have appealed to many as representing a line of work which belongs particularly with concrete work, for two reasons: because of the possible value of the material as a finish for concrete floors and because the work itself seemed to fit in with some of the trades of concreting. For months the Editors have been collecting the experience of those who have in some way had experience with this material. It is recognized that the facts as presented do not represent the last word—the last word cannot be written for years to come—and the Editors urge every one who has had experience with the material in any way to send an account of his experience to this magazine. Such letters will be considered confidential where desired, but they will be valuable, as the greater the mass of testimony, the nearer the truth can conclusions be drawn.

This magazine is neither for nor against the magnesite floor—the material—but it wishes to hold an optimistic attitude toward a material that seems to have much merit and which is of interest in the concrete field because of the two reasons given.

Unfortunately composition flooring has proved an unusually attractive field for "blue-sky" merchants who have sold "secret formulas" and territorial rights that have in too many instances proved valueless to the purchaser. The vendor has in many cases exaggerated the ease with which the business could be made profitable.

The presence of this type of promoter in the field has too often thrown discredit on those who are honestly trying to sell good material and to do quality work. Those who are trying to add a valuable material to the resources of the field deserve hearty good will.

Making Up For Lost Time

FROM almost every quarter of the field come unmistakable signs of business "looking up." Contractors are getting ready for a busy season. Things stop or slow up for reasons of *doubt* for only just so long and then business has to get busy and make up for lost time. Contractors will be busy helping business make up for time lost in the last year and they will be making up a lot of their own lost time as a consequence.

A School of Methods

SOME further details of plans being worked out for the Cement Show in Chicago this year are published elsewhere in the issue. It really seems that architects and builders particularly are to have a much better opportunity than they have ever had before to study, not merely the essential equipment of the field in its newest developments, but to gain some valuable first-hand information as to materials and methods of handling them in concrete construction.

To Combine the Road Organizations

AN effort is being made to bring the Am. Road Builders' Assn. and the Am. Highway Assn. together in one big educational organization. We have heard of but three reasons why these organizations have not combined before: 1—Petty differences among founders and officers as to the name of the combined associations. 2—One organization sought to make its strongest appeal to the builders of roads while the other was more concerned with Good Roads propaganda. 3—Two organizations with conventions each year in distant cities had a bigger influence, for purely geographical reasons, than one organization could hope for.

The first reason is not worthy of discussion. The second reason may be disposed of with two comments. The very nature of Good Roads in this day of their extensive use makes them their own best advertisers. The need for propaganda is not so great as it was. The road problem is a matter of dollars and cents. Road problems are problems for specialists—the administrative heads of highway departments, but most of all the men who do the work. As a matter of fact, both organizations have been attempting both ends of the work—the propaganda and the practical problems. The practical man has been served indifferently. For ideas as to efficient *conventioning* we commend association officials to the report of the proceedings of the First National Conference on Concrete Road Building. By the way, the Second Conference is to be held in Chicago next month.

Reason No. 3 is not so easily disposed of. It does seem, however, that one convention will attract men who would feel like declining two *rival* invitations. Geography is not so important as it would be were there a scarcity of printers' ink. By all means go to a convention and rub ideas if you can. But, one *good* convention will attract more accumulated knowledge and spread it farther than two *almost* good ones.

Concrete Houses in Edinburgh

When the old, crowded city of Edinburgh started to make attempts to reduce the cost of building for the working classes, it was very natural that concrete should be sought as the material with which to find the remedy. At a recent meeting of the Edinburgh Dean of Guild Court, J. MacIntyre, the Lord Dean of the Guild, commented strongly upon the wonderful success made with concrete in the construction of commercial and public buildings and recommended it for houses to be erected for the working classes. In this connection, plans have been before the Tipton Urban Council for the erection of workingmen's houses in reinforced concrete and two houses built of reinforced concrete are to be erected as samples and, if not approved, will be demolished. In the Renfrew Garden suburb 69 concrete houses have been built of concrete blocks with a 2-in. cavity and a total thickness of 9″. Externally they are treated with rough-cast. The interior partitions are formed with coke breeze concrete slabs. The accommodations given in the houses vary from two to five compartments, and each house has a bathroom, scullery and pantry. The living rooms in the smallest houses are 12′ x 12′. The rents range from $75 to $135 a year.

Engineer Builds Economical Concrete House With Simple Equipment

The house which is the subject of this article is valuable as an illustration of what can be done with concrete by an individual not equipped with commercial forms, who expects to build his own residence only. J. F. Hahn,[1] who has for some years been engaged as designing and constructing engineer on various classes of reinforced concrete work, was in the same position as many others; he realized distinctly the advantages of a concrete house, yet was confronted with the impossibility of securing a favorable contract price as compared with other materials, owing to the unfamiliarity of most builders with this class of construction.

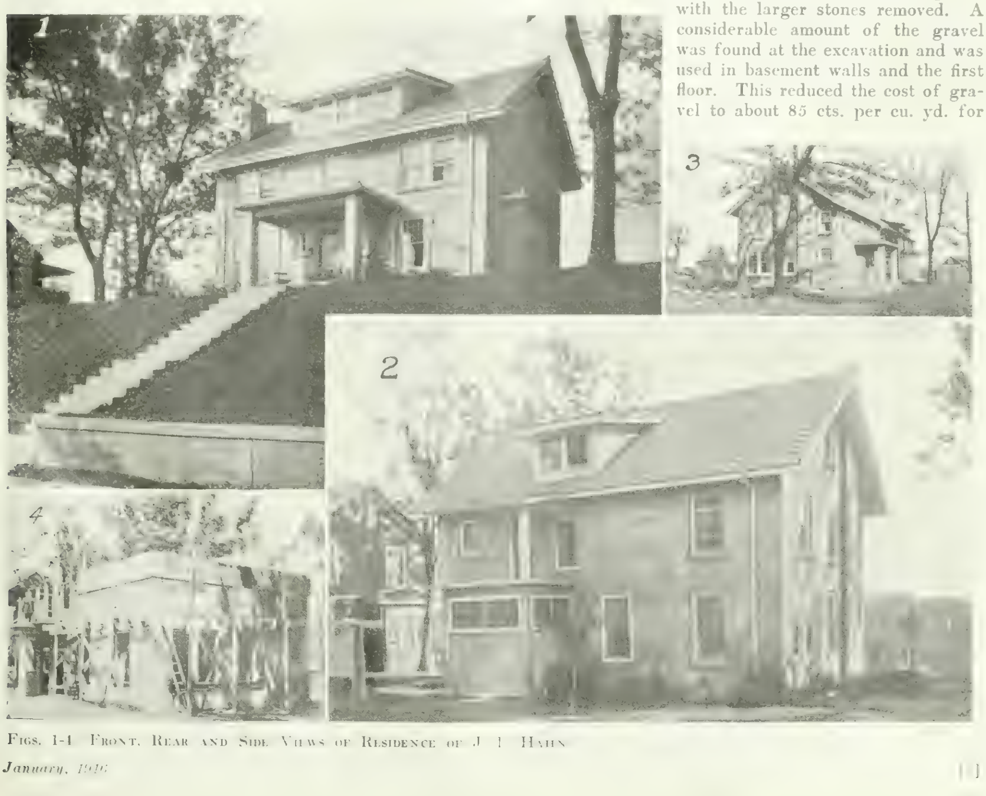
The house is from the owner's plans and was constructed under his supervision. It is as shown by the illustrations, extremely plain in outline, but it is well proportioned and well suited to its surroundings; situated on an elevation among stately old trees, its simple, strong lines stand out in a particularly favorable setting.

The house is 25′ x 36′ in plan, the basement height from floor to floor is 7′ 8″, the first story 9′ 6″, the second story 8′ 6″. There are a front porch, a rear porch and a sleeping porch. The house contains nine rooms and a bath, besides the basement and the attic. As will be seen by the plan, the living room and the dining room occupy the entire front. In the living room is a concrete brick-faced fireplace. The entrance is protected by a vestibule. At the rear of the first floor are the library, the sewing room and the kitchen.

The second floor provides four bed rooms and a bath room. Ample closet room is provided, including two linen closets. From the hall access is provided to the sleeping porch at the rear of the house and to the attic, which contains a large amount of storage space and could, if necessary, be divided into three sleeping rooms. The basement is subdivided by concrete partitions which support the main partitions and the first floor. Aside from the usual space for heating plant and fuel storage, there are a good sized laundry and a store room in the basement.

CONCRETE

Concrete was of bank-run gravel with the larger stones removed. A considerable amount of the gravel was found at the excavation and was used in basement walls and the first floor. This reduced the cost of gravel to about 85 cts. per cu. yd. for



FIGS. 1-4 FRONT, REAR AND SIDE VIEWS OF RESIDENCE OF J. F. HAHN

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[1] Civil Engr., Jackson, Mich.

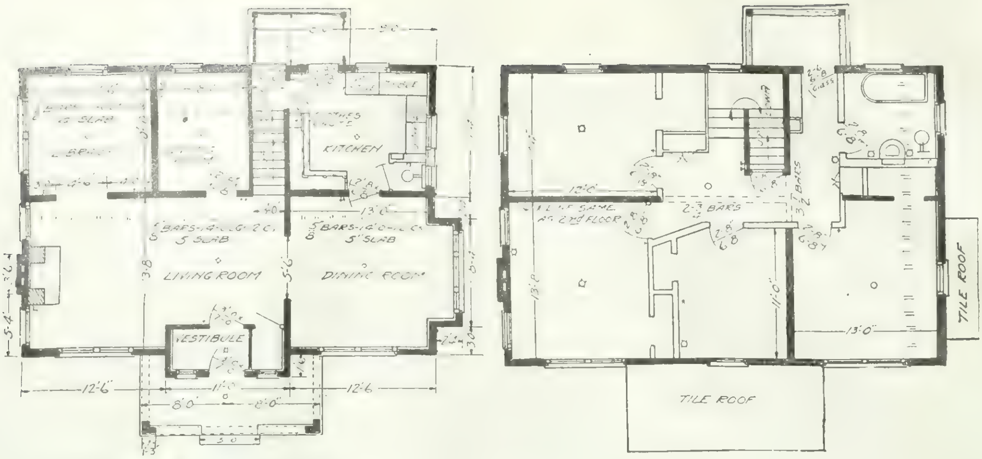

Fig. 5—Floor Plans, Showing Steel Used

the entire building. Cement[2] was used to the amount of about 175 bbls. and cost $1.50 delivered at the job. A continuous mixer was rented for the work.

All concrete above the basement walls was mixed approximately 1:4½, cement and pit-run gravel. The concrete was very dense and practically waterproof.

Reinforcing—The walls were reinforced horizontally with ⅜-in. x ⅜-in. twisted bars 16" o. c. and the same size bars were placed around openings.

The reinforced concrete floors are supported on concrete bearing walls except for short spaces carried on girders as shown on the plans. The floor slab was reinforced with square twisted bars of size and spacing shown.

Forms—The wall forms for the superstructure were sectional, 2' 6" high, made of 3-in. x 10-in. boards nailed to 2-in. x 4-in. pieces at about 2-ft. 6-in. centers. Inside and outside forms were held in place by $\frac{5}{16}$-in. bolts and spreaders. The inside of the outside forms was covered with a cheap grade of 2-ply roofing felt having a rough grained surface. The roofing felt was used to avoid the smooth, glassy surface characteristic of concrete where smooth wood or steel forms are used. The paper also served as a gasket between the forms and the concrete wall previously built and in nearly all cases the form was watertight and made a joint that is barely noticeable. After the concrete work was finished, the forms were taken apart, the boards were used for roof sheathing and the 2-in. x 4-in. pieces for fillers in second floor partitions. The rafters and the second floor ceiling joists were used for supporting floor forms and for staying. In this way all the lumber that could be charged to forms is the waste from cutting, which did not exceed 500 bd. ft.

Handling Concrete—The concrete was handled by hand and no hoisting equipment or runway was used. As the concrete was poured in sections about 30" high, the first section was easily handled with buckets from the ground. The second section was poured by a man standing on a portable platform who took the bucket as passed to him from a laborer on the ground. The platform was moved along as the forms were filled. The same procedure was followed by adding an additional man for each rise of the forms, up to the second floor, when the material was hoisted to the second floor by three men at the rear porch and the procedure was repeated. While this may seem a crude way of handling the concrete, when one considers the very small quantity that is required for a 6-in. wall, 30" high, allowing for openings, and that this was an isolated job which would not warrant an investment for staging equipment, it will be found that this was probably as economical a procedure as could have been followed. The light mixer used was easily moved from one side of the house to the other so that the concrete had to be carried a very short distance.

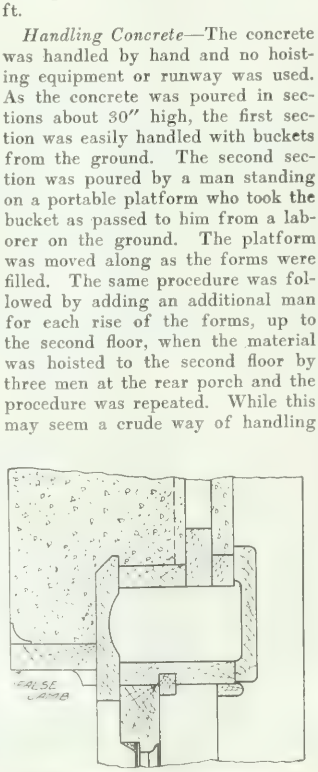

Fig. 6—Window Frame Details

The first story required two days to set up forms and pour the concrete for each section, thus requiring 8 das. to build a story height. The work was done by a superintendent, one carpenter and two laborers for the first two sections, three for the third and four for the fourth. It required 6 hrs. to 7 hrs. to set up the forms and 2 hrs. to 3 hrs. to fill them with concrete. The work was so arranged that all forms were filled at the end of each day. This part included the concrete partitions.

The second story walls without partitions were built in 4 das., or at the rate of a section per da. To pour the concrete an additional laborer was employed for each additional section in height. The additional laborer was used only a few hours each day while pouring concrete, the local labor situation permitting this arrangement.

SURFACE TREATMENT

The forms, covered as previously described with roofing paper, did not leave the surface in a glassy condition and there was comparatively little streaking from leakage. While the house looked rather spotted at first, two years' exposure to the weather has evened up the color to a remarkable extent and the surface, which is practically as left by the forms, is far from unattractive. It has a sturdy individuality, it is an honest expression of an honest material and will continue to grow more attractive as the years pass.

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[2] Mich. Portland Cement Co., Chelsea, Mich.; Peninsular Portland Cement Co., Jackson, Mich.

ROOFING

The roof frame is of wood and in it were utilized the plank which had been serving throughout the job as staging and supports for floor forms. Practically every scrap of lumber could be used in sheathing the roof, so that there was very little waste. As roofing tile was to be used the roof was prepared by covering with waterproof paper which was held on by lath running up and down the slope of the roof. These laths also act as furring strips for horizontal 1-in. x 2-in. strips to which the tile are secured. The tile were made on a Brock roofing tile machine,[3] which is a simple piece of equipment consisting mainly of an arrangement for molding pallets which give the proper shape to the bottom of the tile and a troweling member running on guides which trowels and gives the proper form to the top surface. The tile were first made to an approximate shape and then a surface coating of red iron oxide was sieved over them and the troweling finished. This gives a very good color which seems to be fully equal to that of the burnt clay tile, while irregularities in placing the color give variety in the depth of the shade which results in a very pleasing roof. It is interesting to note that the tile were made and placed on the roof at about $12 per square.

CONSTRUCTION DETAILS

Fortunately the mistake was not made in this house of attempting to secure a dry and thoroughly insulated building by means of a single concrete wall and provision was made for furring and lathing. This is done as illustrated in the sketch, by tacking V-shaped strips to the forms at proper intervals, to which vertical furring strips were afterwards nailed. The concrete partitions and first floor ceiling were not lathed, but the plaster was supplied direct, with entirely satisfactory results. Considerable thought was expended upon a proper window frame detail which should be simple and entirely weather tight, yet which could be used readily with a 6-in. wall and not interfere with the forms. The result of Mr. Hahn's work is shown in an accompanying detail. Study of the detail will show that the jamb, headpiece and sill could be separated from the rest of the frame and readily replaced. A false jamb was used outside, as shown, to act as a form for the concrete. This was, of course, removed and a staff bead put on after the forms were removed. Each frame was set assembled complete, then the jambs were match marked, numbered and taken off until the concrete work was complete. It will be noticed that this style of frame provides not only an airtight joint and a form for the concrete, but also suitable nailing for the interior trim. The porches are of concrete poured in forms, but the panels in the rear porch are of stucco on ribbed metal lath over sheathing. The floor and roof of the sleeping porch are of poured concrete. The roof is colored with red oxide to match the roof tile; the iron oxide was troweled in as with roofing tile. The concrete sills were cast in place in suitable spaces left for them, it being considered easier to do this than to take care of the complications sills would involve in the form work. The chimney is of concrete, poured with the house and provided with square vitrified tile flue lining. The use of concrete has been extended to all the surroundings of the house, as will be noted by the long flight of concrete steps, the retaining wall, sidewalks and even the concrete lawn roller and T-shaped clothes line post which can be seen by close inspection of Fig. 2.

INTERIOR FITTINGS

The finished floors are of oak and yellow pine, nailed to 2-in. x 2-in. screeds laid directly on the concrete sub-floors, except in the vestibule and the toilet room, where ceramic tile floors are used. All partitions not indicated as being of concrete on the plans are framed of wood in the usual manner. The trim on the first floor is of oak of a plain and tasteful design and the second floor rooms are finished in yellow pine, enameled, and birch mahogany. A vacuum vapor heating plant has been installed, which, together with the concrete construction, has reduced very considerably the fuel required for heating.

The kitchen and the laundry are piped with gas and in the laundry is installed a Diehl automatic water heater which supplies hot water at all times to laundry, kitchen and bath rooms. The house is lighted by electricity and gas. The plumbing consists of toilet on the first floor and bath room on the second floor, with the usual equipment of kitchen plumbing, and an automatic soft water pump in the laundry. A clothes chute communicates between the laundry and each floor.

COST

In estimating the cost, the owner's time as superintendent is included at $4 per day, but no contractor's profit is added in the total cost, although it is figured on certain parts of the work which were let out on contract. It may be added, however, that this work was done at an exceptionally favorable time and that the figures obtained from contractors were probably unusually low. The notable feature of this work is that, in spite of the fact that this was an isolated building, erected by workmen who had had little or no previous experience in this class of work, a fact which was, to a certain extent, offset by favorable prices for materials and favorable labor conditions, the cost of the concrete work, which includes the basement and entire structural part of the house, came to slightly more than $1,000. The remainder of the cost went into woodwork, millwork, plastering and accessories which would necessarily be figured at the same cost in any kind of house. It is evident, therefore, that not only has this concrete house not cost more than other types of structures, but in all probability Mr. Hahn has actually effected a saving over any other material. He has a house which will require no upkeep for years to come, which removes to a large degree the fire hazard as evidenced by the lower insurance rates, which is more easily heated in cold weather, yet is cool in the heated season, and which will continually become more in harmony with its surroundings as the years pass.

COST DATA

Excavation contract	$ 40.00	$ 40.00
Cement	266.64	
Gravel and sand..	116.10	
Steel	79.85	
Mixer rental	20.00	
Labor on concrete and forms	578.00	
Total concrete cost....		1,060.59
Roof tile and sheet metal contract	236.00	
Plastering contract	228.30	
Lumber	528.19	
Mill work	158.49	
Carpenter labor	420.44	
Total lumber and carpenter		1,107.12
Hardware, rough and finished	93.43	
Plumbing contract	308.00	
Heating plant	336.83	
Painting (does not include walls where left white)..	133.45	
Electric light wiring and fixtures	108.40	
Hardware, heating, plumbing, light and painting		980.11
Incidental mason supplies .	56.54	
Miscellaneous labor	28.02	
		$3,736.68

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[3] Brock Bros., St. Louis, Mo.

Concrete Fireplace and Concrete Pergola Columns at Low Cost

The accompanying detail and illustration from photograph showing a hooded fireplace in the Italian style are supplied through the courtesy of Brainerd & Leeds, architects, Boston, who designed the work in concrete for a college society at Wellesley, Mass. Mr. Brainerd writes of the fireplace and also of a concrete pergola:

The building was erected in sections—first the great central room, which originally had no fireplace. One was added a little later and to make as little disturbance as possible, the chimney was put on the outside of the building. When we came to add the wing on this side a fireplace was desired in the new room, but to add one of the ordinary form to the projection already existing would tend to cut the room in two and spoil the effect, so that we decided that we needed a hooded form, such as are found in the old French and old Italian buildings.

Now the college limits the amount the societies may spend on their buildings. Stone would have cost more than we could afford. Gravel from the cellar excavation was so well proportioned that it needed only the addition of cement to make good concrete, so we decided to cast it in place. We cut out back of the old chimney so that the concrete bonded into it as far as the lining of the original fireplace.

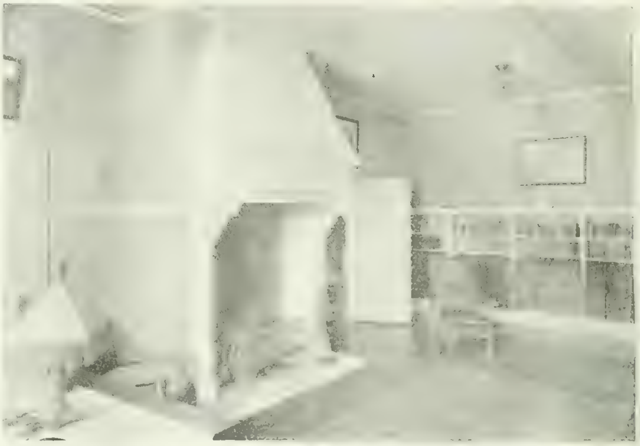
Fig. 2—The Completed Fireplace

The carpenter's time for building the forms did not exceed three days. The concrete when stripped was finished by scouring the surface with a wash of sand and white cement. The results are shown by the illustration.

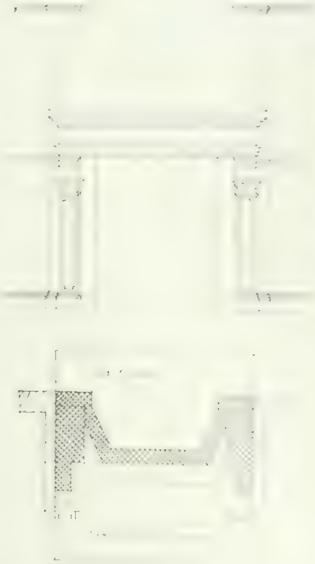
Fig. 1—Elevation and Plan of Concrete Fireplace in Wellesley College Society House

Similar conditions in regard to materials and cost existed in building a pergola. We found that we could get the effect of a simple Greek Doric column by making the molds of flat strips, tapered to give proper entasis, the number of the strips being the same as the usual number of flutes. We made two sets of forms which took less than two days' time of the carpenter. When set and stayed in position by the carpenter they were filled by the laborers without extra cost for supervision beyond that required for the general work.

The foundations were cast in holes in the ground and a couple of rods inserted to bond the column to them. We were able to cast a pair of columns every other day. The caps were cast separately.

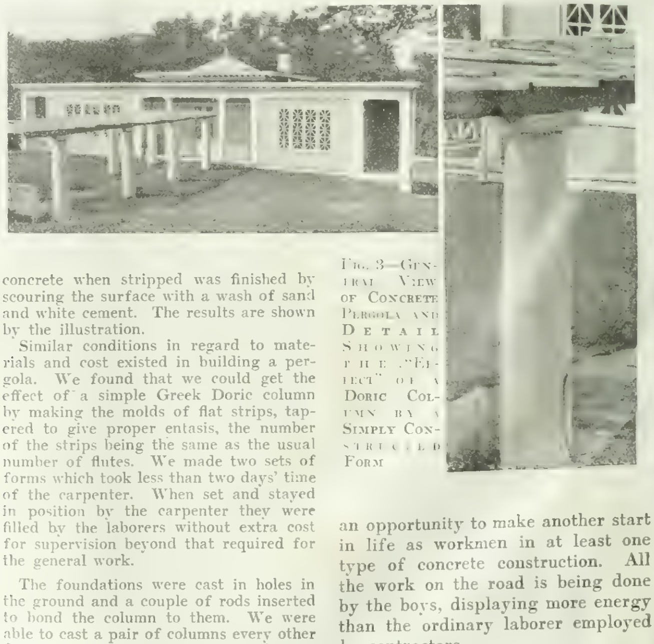
Fig. 3—General View of Concrete Pergola and Detail Showing the "Effect" of a Doric Column by a Simply Constructed Form

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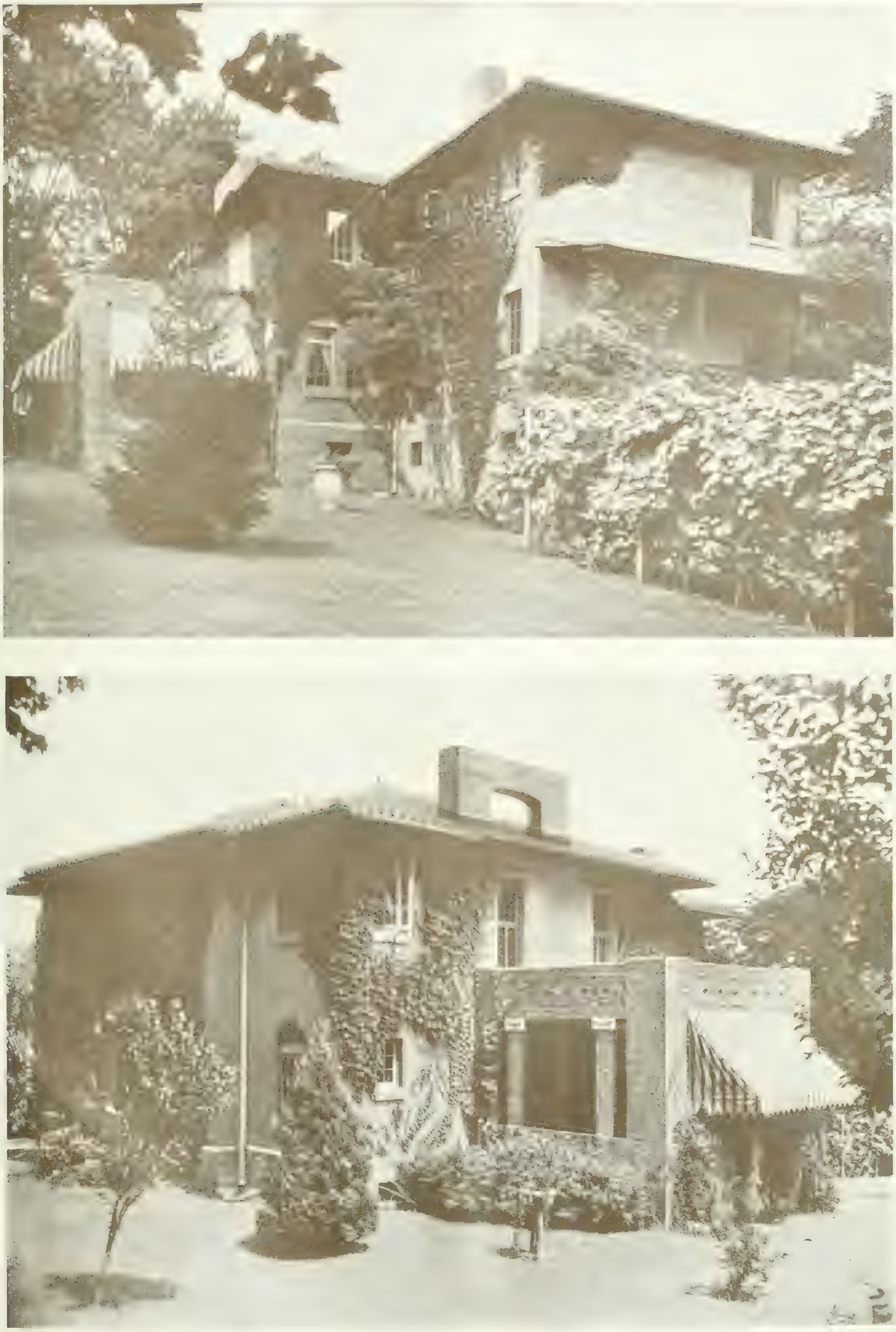
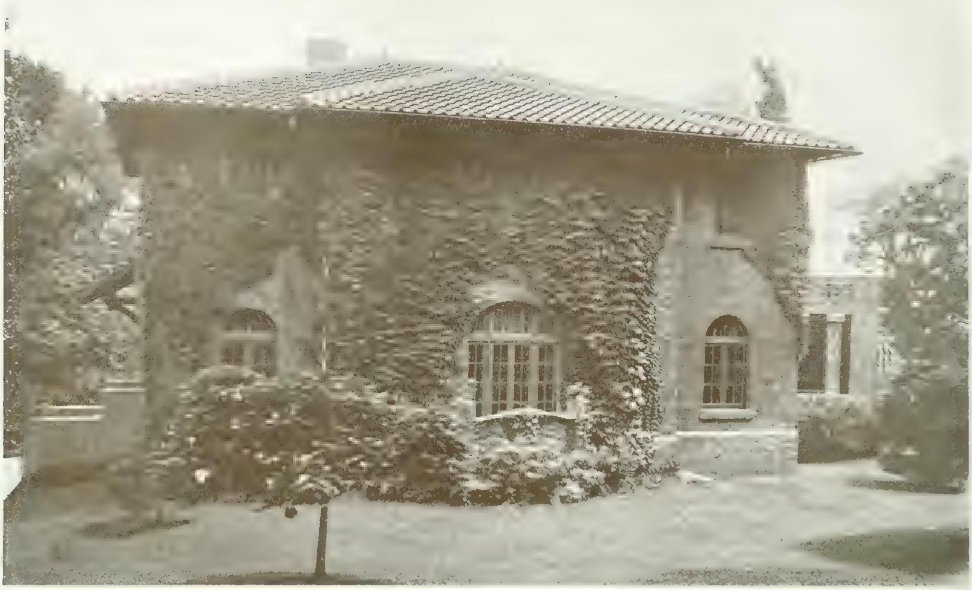
The Cheshire reformatory of Connecticut is about to lend its boys to the State Highway Commr. for use in constructing a concrete road in the vicinity of the reformatory. The State is to pay them at the rate of 50 cts. a day for their labor. While this will save considerable money in the construction of a permanent concrete highway, the result is two-sided inasmuch as it tends not only to produce an economical road, but also to give the boys interesting work and an opportunity to make another start in life as workmen in at least one type of concrete construction. All the work on the road is being done by the boys, displaying more energy than the ordinary laborer employed by contractors.



Two Views Concrete Residence of Albert Moyer, Eight Years After Construction



Residence of Albert Moyer

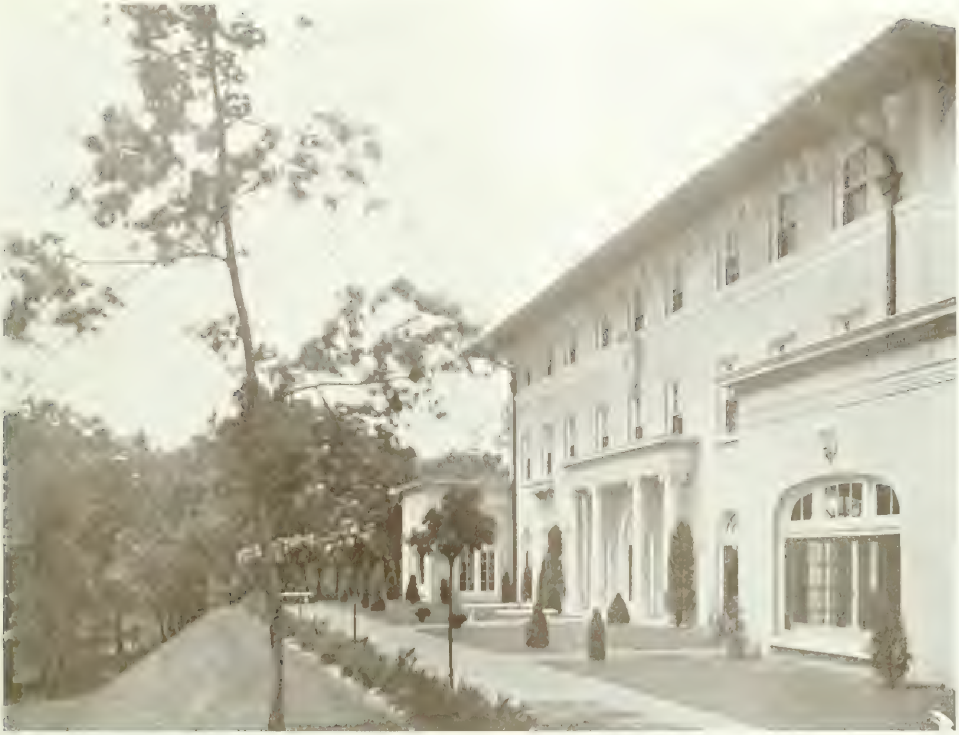
Eight Years of Nature's Work on Concrete House at South Orange, N. J.

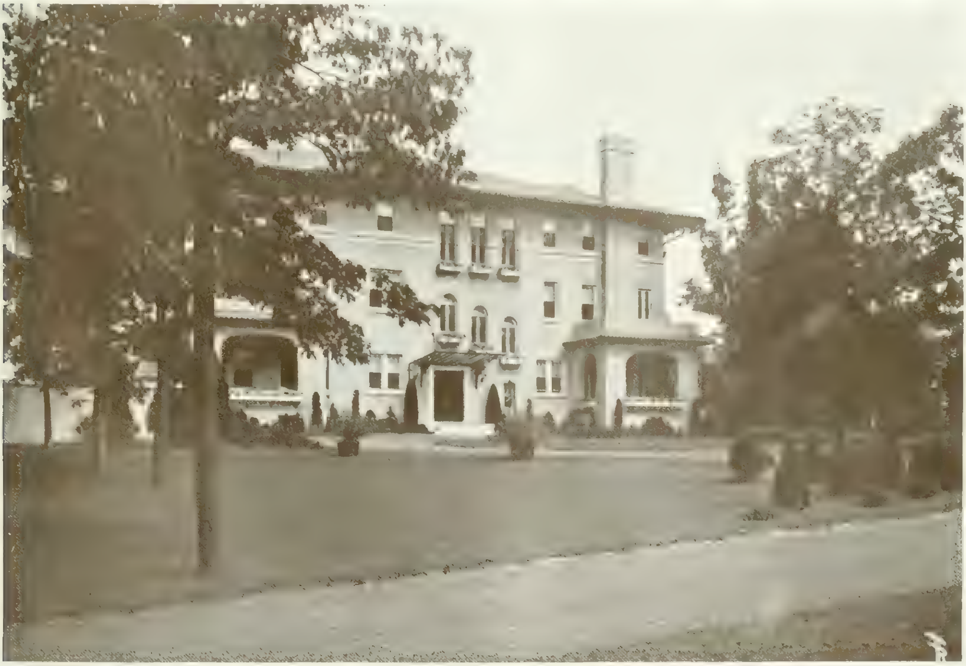
Three illustrations of the home of Albert Moyer, at 324 Ridgewood Road, South Orange, N. J., are shown at this time, not because the house is new, but because it is relatively old among concrete houses. It was built in 1907 and is a most interesting example of the way in which a concrete house, when carefully built, fits into a landscape and comes in time to furnish a beautiful background for the draperies of nature.

The walls are of solid concrete and are not faced, as might be supposed, but are of like quality of concrete throughout. The aggregate was carefully selected to give a certain effect in the finished work and instead of having a plaster or a stucco surface the concrete was scrubbed and cleaned to expose the aggregate immediately after the removal of the forms. This concrete was composed of 1 part cement, 3 parts limestone and white marble, the size of sand, and 1 part ¾-in. trap rock, giving a good color variety. There is a great deal of exterior tile decoration which, however, is unobtrusive, as the colors of the tile inserts are primitive, pastel shades in low tones. All the tiles were hand-made and were burned in a primitive manner. The lines of the house are very simple, almost severe, yet this severity of line is fully compensated for by the richness of the entire concrete surface, and now after the lapse of a number of years it is further enriched by the shrubbery and the vines.

The house is 42′ wide, not including the loggia, and 55′ deep. The windows are casement made, with English leaded glass. The roof is of Japanese pan tile, run of kiln, and some of the tiles are smoky red, others salmon, and all the various shades are mixed together, giving a most pleasing result. The architects are Tracy & Swartout, N. Y. C.

House Built in Auckland, N. Z., for E. Langguth. See elsewhere in this Issue





Two Views Residence of Louis K. Hyde, Plainfield, N. J., Franklin B. Ware and Arthur Ware, Architects

Detail of Louis K. Hyde Residence

Interesting Residence on Watchung Mt. Has Features of Concrete

Features of the residence of Louis K. Hyde at Plainfield, N. J., as designed by Franklin B. Ware and Arthur Ware, architects, N. Y. C., involved the use of concrete in several very interesting ways. The house was built on top of Watchung Mountain and in preparing the site and the excavation there was excavated a large amount of rock which was crushed and used in the concrete. The hauling problems, otherwise, would have made the cost of building materials excessive, because of a haul of several miles up the mountain side.

The accompanying illustrations give an idea, not only of an interesting plan, but of very attractive details in many respects. The construction is fireproof, all the foundation walls being of concrete, the upper walls of tile and the floors of reinforced concrete. The finish outside is of stucco of a most pleasing texture. The floors are of heavy construction, using heavy Clinton wire[1] and rod reinforcing and, as no cinders could be had without an unusual haul, the stone which was excavated on the site was used in place of cinders.

In the garage, in the stables in connection with the residence and in the entire attic, which is given over to the use of children for a playroom, there is a smooth granolithic finish.

The stucco was put on in three coats, the finishing coat being a mixture of white Atlas cement[2] and white Lakewood sand, dashed on.

A great deal of concrete trim was used for the brackets under the roof rafters and for brackets supporting flower boxes and for all window sills, cornices, porches, porticos, copings for service yard, etc. Concrete trim was also used for the mantels, one in the entrance hall and one in Mr. Hyde's den and a cast concrete fountain in the breakfast room. Models and molds for all of the exterior cast concrete trim were made in New York City[3] and shipped to the site, where the actual casting and curing was done. Tooling and also other finishing work was done after the work was in place. Casting the exterior trim at the site saves a great deal in view of the peculiar hauling problems. The molds for the work being comparatively light, were cheaply shipped, and many of them were used repeatedly. The interior concrete trim ,including the mantels[4] and the fountain,[5] were made in N. Y. C. These are in reproduction of antique stone, the fountain being of a lighter finish intended to blend nicely with the stucco sirface of the walls.

The finish of the attic is really a feature of the house. It was well lighted from two ends and it was decided to utilize the entire area for the children. Because of this it was desirable to make it as nearly indestructible as possible. The floors are granolithic and the walls and ceilings also have a smoothly finished Portland cement surface. All corners and angles are rounded and there seems to be absolutely nothing in the entire room either to chip or to wear out. These concrete surfaces were finally painted with a light tone gray-green cement paint in order to give more light.

The house is very complete throughout. Besides the two plans shown there is a very complete basement and a full third floor, besides the attic.

In connection with the grounds there is a tennis court constructed of reinforced concrete on a solid stone foundation. This stone foundation, however, is natural to the site. The court was constructed very much as the reinforced concrete floors were built, with heavy Clinton wire mesh and twisted rods. It was made in

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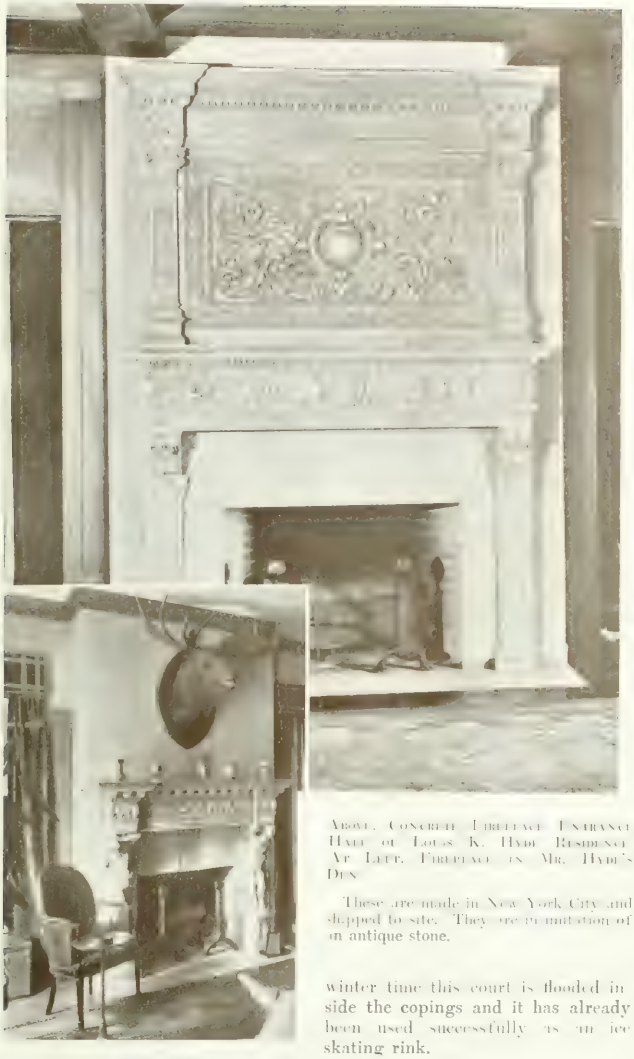
[1] Clinton Wire Cloth Co., Clinton, Mass.

[2] Atlas Portland Cement Co., N. Y. C.

[3] Rochette & Parzini, N. Y. C.

[4] Jacobson & Co., N. Y. C.

[5] Erkins Studios, N. Y. C.



Above, Concrete Fireplace Entrance Hall of Louis K. Hyde Residence. At Left, Fireplace in Mr. Hyde's Den.

These are made in New York City and shipped to site. They are an imitation of an antique stone.

sections with expansion joints. The coping around the court is of concrete and in the coping were left holes to receive the supports for the heavy wire mesh enclosure. Around the court are electric light reflectors, so that tennis can be played at night as well as in the daytime. In the winter time this court is flooded inside the copings and it has already been used successfully as an ice skating rink.

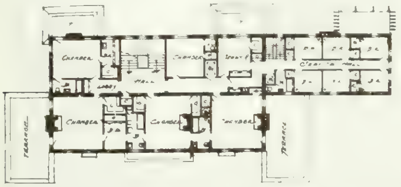
Commission Conducts Tests of Cinder Concrete

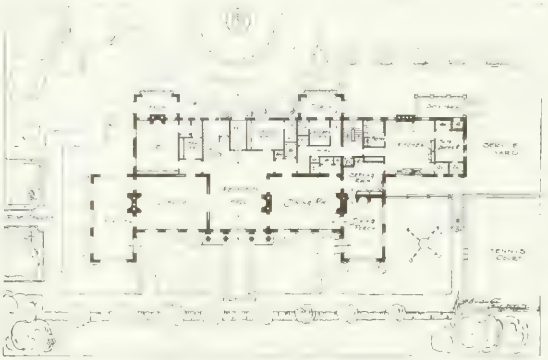
A bitter fight is to be waged in the Massachusetts Legislature next year in connection with the merits of cinder mixed concrete. The purpose is to overthrow the report of the Commission appointed by Eugene Foss when he was governor, which drew up a standard code of building laws for the Bay State. In the code thus reported, the 8-in. stone concrete for floors and roofing purposes with iron reinforcement was recommended and electrically treated steel rods used in reinforcing concrete were adversely reported upon. One of the manufacturers of the electrically treated steel rods is having a test conducted by a board consisting of the following engineers:

Jaspar Gibson, engr. for the Clinton Wire Cloth Co., assisted by R. D. Bradbury, consult. engr., Boston, with Engineers H. E. Sawtelle, from the office of Charles T. Main, and W. H. Ham, from the office of French and Hubbard, both of Boston.

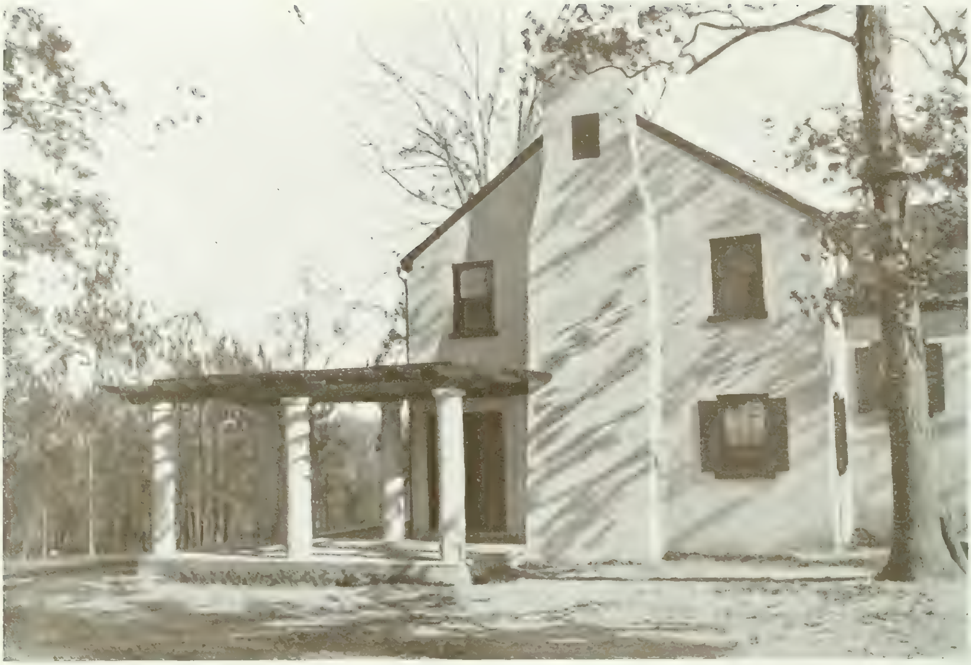
They were begun in the testing plant of the Clinton Wire Cloth Co. and when completed will be the most exhaustive conducted in the U. S. The four wooden forms with the steel net-work laid, as in the construction of a floor or a roof, will be allowed to set for 30 das. before they are subjected to any tests. When the concrete has set sufficiently, tons of pig iron will be placed upon it to show the exact weight the concrete will stand and how much strain will be placed upon it. The result of the tests will not be known for 6 wks. The four forms were laid on the top of concrete piers that were built a year ago and the concrete poured in. The steel net-work was placed in position after the required amount of concrete had been poured and it was then covered with concrete.

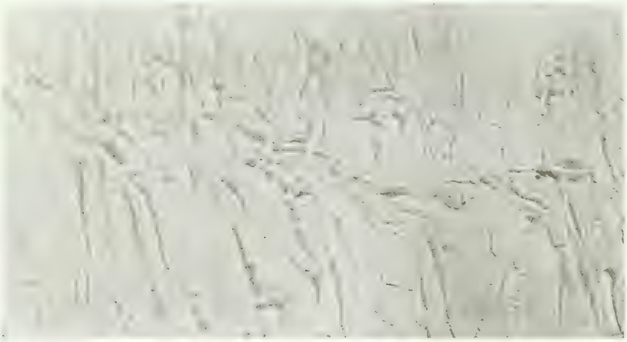
The Chicago Cement Show, Feb. 12-19, will undoubtedly be the biggest cement show ever held.





Second Floor Plan and First Floor Plan, Hyde Residence (Scale 1/56" to 1')

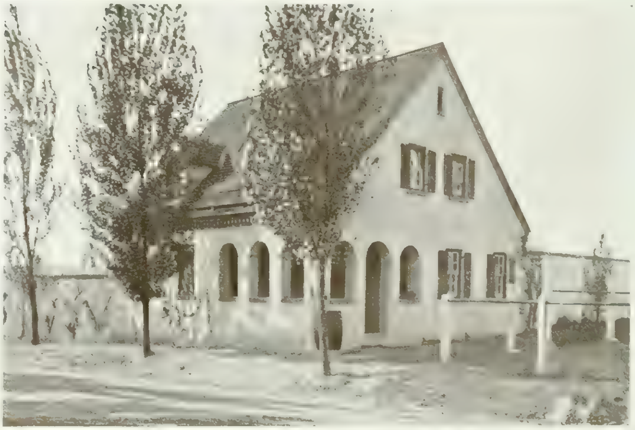




G. Gordon Massey Residence of Poured Concrete at Middleburg, Va. Detail of Stucco (Area Shown, 2.3 sq. ft.) at Left. (See elsewhere in this Issue)

$2,500 Concrete Cottage, Thomas Estate, Near Middleburg, Va.

The illustration shown is that of a cottage at Huntland, the estate of J. B. Thomas, near Middleburg, Va. This is one of numerous concrete cottages, some of which have been previously described in Concrete.[1] This cottage is 25′ x 25′, outside dimensions, and contains six rooms. The walls are 12″ thick for the first story and some of the cottages have walls 6″ thick and some 8″ thick above that level. The concrete for this construction is as described in previous issues for other work on the Thomas estate where a thin, very wet, mix of concrete was used and a large quantity of crushed field stone embedded in the mixture. Similar construction was used for the Murphy house and the Massey house at Middleburg, described elsewhere in this issue. The walls are stuccoed with a mixture of Atlas[2] white cement and sand in equal proportions. Each of these cottages cost about $2,500.



"Wall" Cottage at "Huntland," Estate of J. B. Thomas, Near Middleburg, Va.

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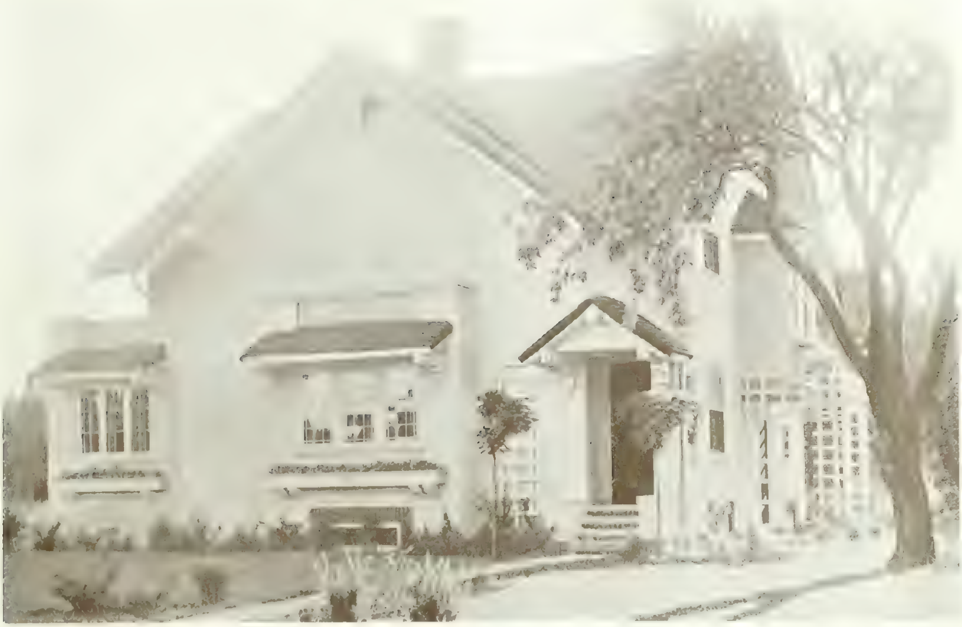
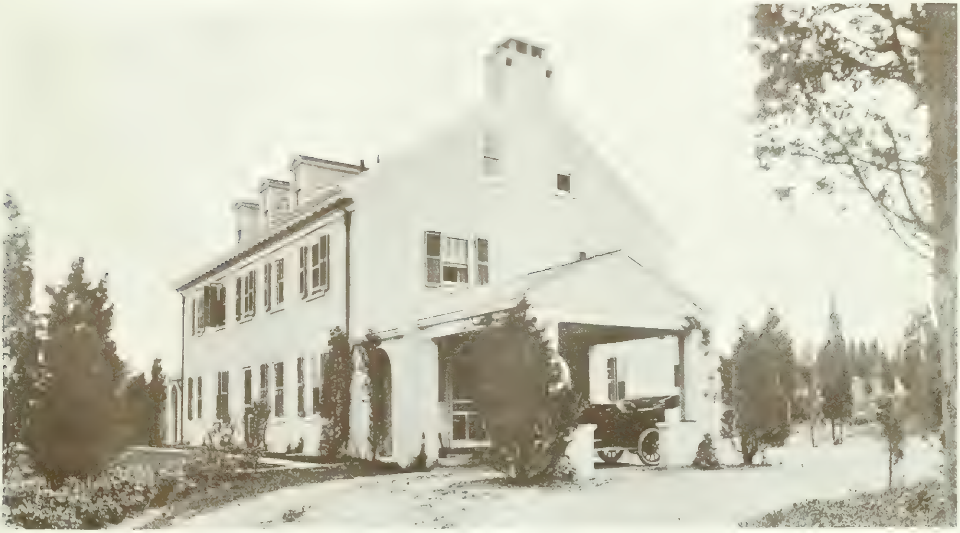
[1] Jan., 1914, and Jan., 1915

[2] Atlas Portland Cement Co., N. Y. C.



Residence of William E. Schulzke, Architect, Moline, Illinois. Stucco on Metal Lath. (See elsewhere in this Issue)



Residence at New Canaan, Connecticut, of William A. Boring, Architect, New York City. Poured Concrete With Concrete Floors. (See elsewhere in this Issue)

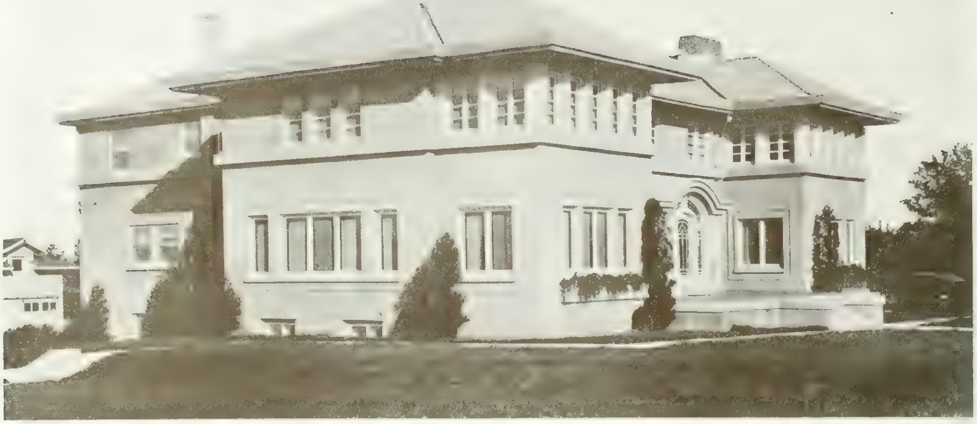


Fig. 1 Residence F. L. Williamson at Kansas City, Missouri

An Example of Fireproof Residence Construction at Kansas City, Mo.

The subject of this article is the residence of F. L. Williamson.[1] It was inevitable that Mr. Williamson's close contact with the cement industry should have impressed upon him the value of concrete as a residence material. The plans are by Shepard and Belcher[2] and the concrete structural features were designed by the Trussed Concrete Steel Co.,[3] which furnished the reinforcing material.

Study of the plans shows the house to be 68′ wide and 63′ deep. The basement is fully utilized, containing a fireproof garage, man's room, laundry and work room, besides space for the heating plant and for general storage. A reinforced concrete cistern occupies the entire space under the front porch. The feature of the first floor is the large living room, with its heavy beamed ceiling.

The first floor also contains a library, dining room, kitchen and two spacious porches. The second floor provides two large sleeping porches in addition to sleeping rooms.

It is obvious that in a building of this kind details must be very carefully planned in advance or considerable annoyance will occur. All electric wiring was located in conduits which were placed before pouring the slabs and walls. Chases were left for vertical pipes and conduits and such pipes as are subject to variations of temperature were carefully wrapped with asbestos paper and then insulated before the wall was plastered with cement mortar. The first and the second floor finish in the principal rooms is 1¼-in. oak nailed to strips embedded in the concrete. The kitchen and the servants' room, basement and third floor slabs are given a granolithic finish, as are also the basement stairs and the stairs from the second to the third floor. The enclosed porches are floored with Adamantile[4] and the open porch at the front is floored with red concrete tile 9″ x 9″, set with black mortar joints. It will be noted that this porch is really the roof of the 16-ft. x 32-ft. concrete

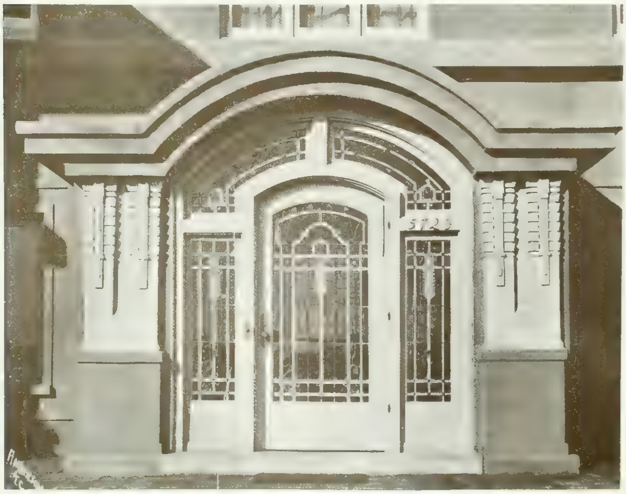


Fig. 2 Entrance F. L. Williamson Residence

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[1] Vice Pres. and Gen. Mgr., Dewey Portland Cement Co., Kansas City, Mo.

[2] Architects, Kansas City, Mo.

[3] Youngstown, Ohio

[4] National Mosaic Flooring Co., Mobile, Ala.

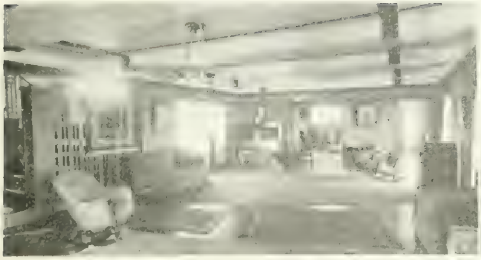

Fig. 3 Living Room Williamson Residence

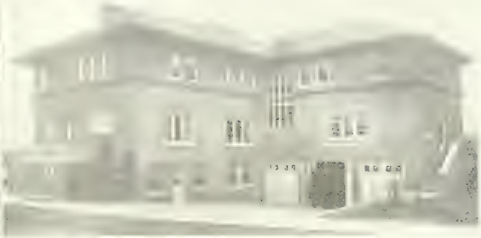

Fig. 4 Rear View Williamson Residence

cistern. The water from the cistern is pumped by a lift actuated by city water pressure to a reinforced concrete tank in the attic. The attic floor slab forms the bottom of the tank. The ceiling of the library is furred and all ceilings are plastered with Keene's cement, but the walls are plastered with Portland cement mortar.

The exterior finish is stucco direct on the concrete wall, the rough concrete surface forming an excellent key. The body of the stucco is rough-cast, but smooth borders are left around the windows at the sides of the building, which give a very attractive finish. At either side of the main doorway and at the corner of the second floor sleeping porches of ornamental cast stone were used, as can be best seen by an inspection of a detail of the main entrance, shown elsewhere in this issue. This ornamental work was cast on the job in plaster molds. The molds were set in place and the rough concrete placed around them, together with the proper reinforcing. The fire place on the north porch is of Caen stone and extends from floor to ceiling. The fire place in the library has a Caen stone facing with a wood mantel.

INTERIOR TRIM

The trim of the first story is oak; the second story has white enamel and mahogany finish. The wall decorations are entirely of white lead and oil applied directly to the plaster. The windows are nearly all casements, opening out.

CONSTRUCTION

Work was started Oct., 1914, and the building

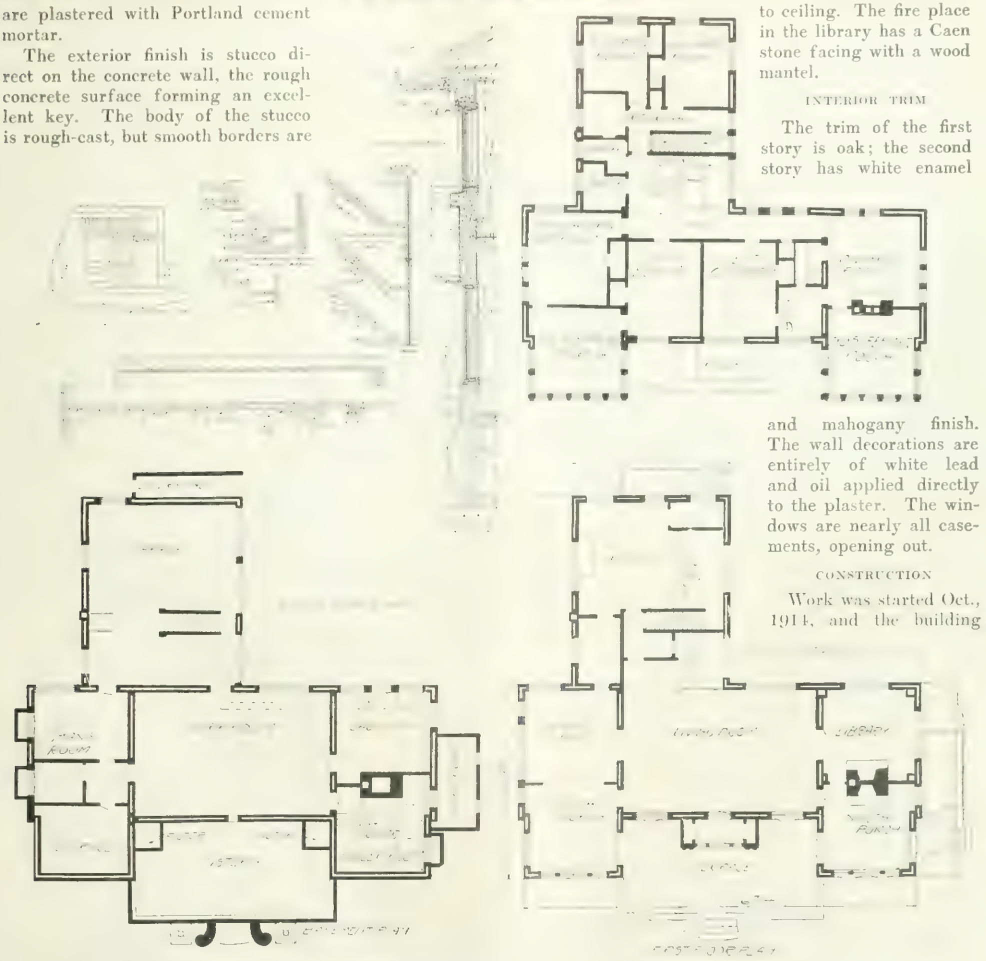

Fig. 5—Plans and Details Williamson Residence

was completed ready for occupancy the first week in July, 1915.

Reinforced concrete footings 12″ deep were placed under all walls. On this footing, work was started with hollow wall machines,[5] building a 4-in. outside and a 6-in. inside wall with a 2½-in. continuous air space. As will be seen by the illustrations, the front of the house has a very heavy water table extending well below grade. This projection was built with the hollow wall machine by running the inside wall first and then going over the wall a second time with a wall machine having the core removed and building a 12-in. wall at the proper height. The machine was set back 4″ to form the double water table effect and later another 4″ to bring it to the final wall thickness. Flower boxes were cast on this base under the windows in the two front porches.

Floors — Basement walls were brought to the level of the bottom of the first floor slab, the outer wall being continued to the top of the slab, the inner wall being lower by the thickness of the slab. Forms were then placed and the first floor poured. It will be noted that the main partition in the basement and at the end of the living room in the upper stories are also of double wall construction and support the floors. Other partitions are of metal lath on metal studs, plastered with Portland cement mortar. Above the level of the first floor the wall was reduced to two 4-in. walls and continued at that thickness for the two remaining stories. The second and the third floor slab were poured as the wall reached their level. The second floor slab is supported on the inside wall and the third floor slab is cantilevered to form the cornice as shown in the section at Fig. 1, with the gutter molded directly in the slab. It will be seen that a suitable abutment for the rafters is also formed on this slab. The frame for the roof is of wood, being practically the only woodwork in the building aside from the trim. The roof is covered with red concrete tile[6] which form not only an attractive but an economical and exceedingly durable fireproof roof.

The long beams which support the floor of the living room and also span the corresponding space on the second and third floors, are of reinforced concrete 12″ x 14″ in section. A detail of this beam is shown in Fig. 2, just above the basement plan. The first and the second floor slab on these beams are 6″ thick, reinforced with No. 8 Ribbed Metal.[7] Other structural floors are of flat slab construction reinforced with ribbed metal and vary in thickness from 4″ to 6½″, according to area.

The concrete was of cement, sand and 1¼-in. crushed stone. It was mixed in a Big-an-Little mixer,[8] with 4½-h. p. engine[9] located in the basement. A wooden charging hopper was filled through one of the basement windows. From the mixer the concrete was handled in wheelbarrows which were elevated on a lift operated by a hoist on the mixer. The lift was located in the stair well of the rear hall, the stairs being omitted until all other concrete was placed and were then built from the top down. Details of the stair construction are shown at Fig. 5.

COST DATA

As competitive bids were not taken, exact comparative data are not available. It is the owner's belief, however, that the building cost less than it would have, had the wall construction been of stone or of brick. Unit wall costs are given as follows by Geo. E. Lewis:[5] Crushed stone, $1.50 per cu. yd.; sand, $2 per cu. yd.; cement, $1.25 per bbl. The machine operators were inexperienced and were broken in on this job. All concrete walls taken together, including the heavy basement walls, cost 19 cts. per sq. ft., including supervision. The 4-in. double wall figured separately cost 15½ cts. per sq. ft. This is exclusive of the stucco finish.

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[5] Van Guilder Hollow Wall Co., Rochester, N. Y.

[6] L. Hansen & Co., Kansas City, Mo.

[7] Trussed Concrete Steel Co., Youngstown, Ohio

[8] Jaeger Machine Co., Columbus, Ohio

[9] Van Dusan, Roys & Co., Columbus, Ohio

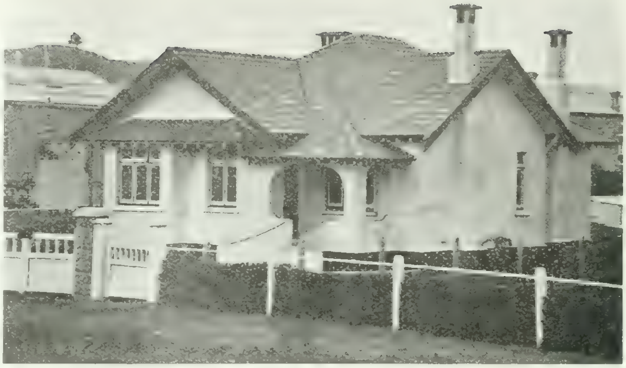

FIG. 1—CONCRETE BLOCK COTTAGE, AUCKLAND, N. Z.

Block Cottages, Plastered Direct, In New Zealand

W. D. Cowperthwaite of the Cowperthwaite Concrete Block Co., Auckland, N. Z., sends some photographs from which the accompanying illustrations of a small concrete cottage were made. The cottage is built of 8-in. hollow concrete block for outside walls and 3-in. concrete block for partition walls, all made on an Ideal machine.[1] The concrete was mixed in a Little Wonder mixer.[2] The roof of the cottage is covered with concrete tile made on a Champion machine.[3] The base of the house below the first floor level and the top edge of the porch steps rail were painted with Glidden paint.[4] The ceilings are lathed with Oregon lath and plastered with pulp plaster. All these items of equipment and materials came from America and in addition the wall paper also. The cement used, however, is a New Zealand cement.[5] The stucco was waterproofed with Medusa.[6]

The Cowperthwaite Concrete Block Co., does not make any face block. Practically all the work it does is for walls which are to be stuccoed. Elsewhere in this issue is shown an illustration of a handsome residence costing about $20,000 built for E. E. Langguth, formerly Austrian consul, in New Zealand. The house is built of concrete block with plastering applied direct to the inside block surface. Inasmuch as Mr. Cowperthwaite is a strong believer in plastering directly on the interior surface of the block he makes frequent use of a testimonial letter from E. Langguth, in which Mr. Langguth says:

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[1] Ideal Concrete Machy. Co., Cincinnati

[2] Waterloo Cement Mach. Corp., Waterloo, Ia.

[3] L. Hansen & Co., Kansas City, Mo.

[4] Glidden Varnish Co., Cleveland.

[5] Wilson's Portland Cement Co., Ltd., Auckland, N. Z.

[6] Sandusky Portland Cement Co., Cleveland, O.

The house you built for me in hollow concrete block has given every satisfaction. I consider the material far superior to ordinary brick and my reasons for saying so are that the walls are absolutely dry from top to bottom. The plaster is perfectly free from even the slightest cracks and in addition shows a beautiful finish. I conscientiously recommend your block as one of the cheapest materials for building houses in our damp clmiate.

In this connection Mr. Cowperthwaite writes:

I have no intention of advocating porous concrete for monolithic work, seeing that it carries so much in requirements; at the same time porous concrete would not be more porous than the brick made here and can certainly be made stronger and much cheaper when in position at the same porosity. While at this time I am devoting all my attention to concrete block work, I built my own house with steel forms.[1] The walls are 8″ thick and the concrete is of a porous character, with only a waterproofing wash on the exterior wall. It is papered direct to the inner wall without plaster and is a success, as no dampness ever comes from the outside and we have no condensation on the inside. Before papering the wall I had a heavy felt paper put on first and then the wall paper. It was an experiment but is all right.

If the block are made 1:7, machine-mixed, all the strength necessary will be there, with sufficient porosity to attend to all moisture from the air, so that condensation is avoided. The outside can easily attended to and penetration overcome. Our hardest problem is to avoid condensation and it can be managed only by having a wall that will absorb moisture. Cement plaster should never be used in dwelling houses for interior work. It is not porous enough. By cement plaster I mean what is ordinarily specified by architects as 1:3 mix. This is a dense material.

My ideas and methods are a little unorthodox and *unless carried out very faithfully would not be likely to prove successful.* With me they are very successful, having been able to carry out my ideas unhampered by restrictions of architects, so that it has been possible in a few years to determine whether I was right or wrong. So far I have not had a suspicion of failure and as my tests have been continuous for 5 yrs. it may be taken for granted that until I hear something that appeals very strongly to me, I am likely to remain unorthodox.

My first block, made 9 yrs. ago, were "dense"—"dampproof"—"weather-proof"—"correctly proportioned" and strong enough to carry a locomotive. These were faced block, "rock" and "plain," the face mixture being 1 cement to 2 sand. Theoretically, they were "the thing," and were, I think, as nearly perfect as block are ever likely to be, some samples of them being still on exhibition at a cement company's office to show what can be done with cement and aggregate suitably proportioned.

An old proverb says: "The proof of the pudding is in the eating," so the test of all concrete block is in their use. Different qualities of block must be used for different purposes.

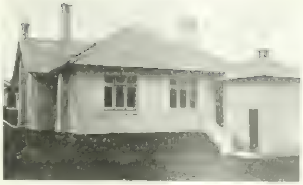

Fig. 2 Rear View Concrete Block Cottage

The first block made were used in building a house for the manager of a local cement company, a photograph of which appeared many years ago in *Concrete*, sent by the then manager, Mr. Greer, who spoke highly of the result. The next were used for an Oddfellows' Hall, which to some extent was in public use. In addition to dense block, the architect had the interior finished in cement plaster, the effect so far as condensation is concerned being easily imagined. As our climate is very moist, at times little streams would race down the walls. A little of that decided, or at any rate seemed to decide, the fate of hollow concrete block; at any rate, it was a decided set-back. A demonstration was given to prove that the block were "water-tight" or dampproof" (the question of strength was never in dispute) by having a well built on the ground in the block yard, the mason representing the public choosing any block he liked in the yard. The bottom of the wall was cemented, the faces of block being out, while the backs of block were left unplastered. The well would measure about 2′ x 2′ and 2′ 8″ high. It was filled to the brim with water, and stood there for a long time, being under very careful observation. At no time did we ever find a leak from the inside of the block, the only loss being by evaporation. This proof was accepted as conclusive so far as the "density" and "dampproof" qualities were concerned—but, the wall showed condensation on the walls, so it was considered too risky to build dwelling houses with them in this climate. There are always those in any community who are "in opposition." We had them there and for a time they had a triumph. Fortunately for humanity's sake, we get a few level-headed men mixed up with them or stagnation would result. One turned up at this time, and most fortunately he made no pretense to be an authority on concrete—or concrete block; he was willing to reason matters out, the result being that he left an order for sufficient block to build a house. Block were to be 1 part cement to 7 parts gravel, and to be left in yard "till called for." Now, who expects concrete block of 1:7, without any pretense at waterproofing them with lime—or anything else—to be dampproof? As a matter of fact they would make good filters. These block were used to build a house that gave every satisfaction, although it was plastered directly on the block on inner walls. It must be noted that all my work has been in a moist climate, no frosts worth mentioning, and no snow. At the same time I should not anticipate much trouble in a colder climate. Special conditions might have to be provided for, which, it seems to me, might easily be done.

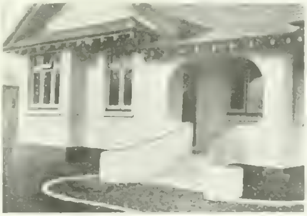

Fig. 3 Detail of Entrance Porch

The next two orders came for block for house building, one of which was leaky through bad workmanship in laying the block. This mason claimed to knew all about them, as he had laid them in America. He made the biggest mess of the lot. In these cases I only manufactured the block, architects and owners arranging and supervising the work to suit themselves.

So far there had not been the slightest satisfaction in supplying block to builders, nor had there been any in following out the instructions of so many learned experts on concrete on how to make hollow concrete block. All sorts of aggregates — sandy gravel, sand only, crushed rock, pumice, scoria of various kinds, had all been experimented on and good block made from all. By good, I mean as regards strength, for with pumice—and some kinds of scoria—it would be practically impossible to make a watertight concrete.

It was at this point that I decided to build a house of hollow concrete block, which should be plastered directly onto block on the inner walls, and stuccoed on the outside.

All so-called expert advice gathered from smoothly worded articles in *Concrete* and other sources, preaching "dense" block, etc., was to be treated as a negative, so that one might get a little relief in a really good positive.

On submitting my ideas to one who is probably the best authority here on cement and concrete, I was taken to task for my small faith in "authorities" and "experts" generally, special mention being drawn to the attitude of *Concrete* on this subject. (Just think what a lot you are answerable for.) As I was risking my own money for my own dwelling, it seemed reasonable I should do as I liked—and did so. The result was not only an improvement on anything that had been done, but the building was almost perfect so far as weather-resisting qualities were concerned. The only points of failure were at two or three window angles, where a little damp crept in under the sill of frame. There has never been the slightest suspicion of condensation in any part of the house.

Since then I have built several, in which stricter supervision eliminated the weak places mentioned, the result being not only what was anticipated, but really all one could wish. Walls are plastered on the outside and finished in rough-cast, all inside plaster being applied directly to the block, and *in no case does condensation take place,* nor do the walls permit our terrible northeast rains to penetrate. I had the satisfaction last week of being commended by the authority mentioned, when he said: "I am convinced now that your method is the proper one for house-building."

While I am writing this we are experiencing a "northeaster"—wind and rain—that seems to get into the marrow of one's bones. For a week the atmosphere has been laden with moisture, and for 16 hrs. it has been steadily driving. If anything could be looked upon as such, and if any condensation would show at all it should be now. To test the walls I have at this moment thrown three half-pints of water onto the bathroom walls, one on top of the other in quick succession—and the merest trifle has reached the floor. The wall absorbed the rest.

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[1] Blaw Steel Constn. Co., Pittsburgh

Now, which condition is more likely to provide a healthy house, "a dense wall" or a "porous wall," provision being made so that the outside wall surface is so protected that it is practically impossible for the weather to penetrate this covering?

[*Editorial Note*—The reader should not fail to note that Mr. Cowperthwaite is not contending with the conditions which favor interior condensation. A hard driving rain is a test of a wall's waterproof qualities, but it is not a test of the qualities which prevent interior condensation. Cold weather outside (not wet weather, with warm, moist air inside provides the conditions which test the insulation of a wall against condensation. The extremes of temperature of the northern part of the U. S. provide much more serious difficulties than those with which Mr. Cowperthwaite contends.]

Calcium Chloride to Accelerate Hardening

Experiments by the Bur. of Standards show that the use of a 4% solution of calcium chloride used as mixing water for concrete materially accelerates the hardening. The acceleration varied somewhat with different cements. In some cases, a 1:2:4 concrete increased 100% strength in 24 hrs. to 48 hrs. Experiments will be continued to show the ultimate value of this material as an accelerator. It is said that its use will add 12% to 15% per cu. yd. to the concrete. It is pointed out that it should not be used in reinforced concrete structures which are likely to be exposed to electrolysis, as these salts would also accelerate corrosion.

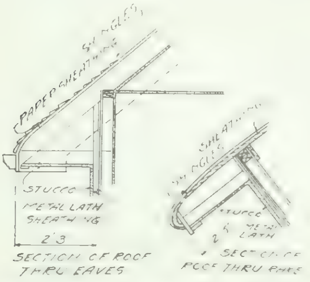

Fig. 3 Roof Details, Schulzke House

Attractive House of Stucco on Frame Built for an Architect

The house which William E. Schulzke, architect at Moline, Ill., built for his own occupancy is shown in some of its interesting features in the accompanying illustrations from the architect's drawings. An illustration from a photograph showing the completed work is reproduced elsewhere in this issue.

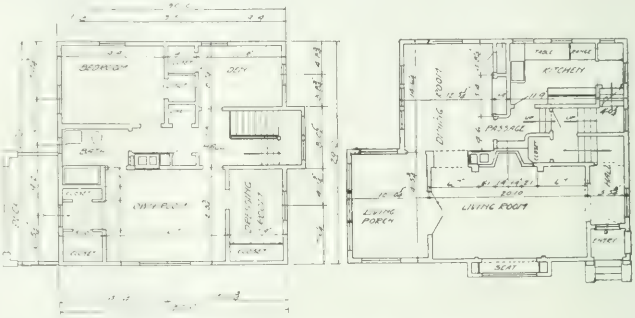

Fig. 1 Floor Plans, William H. Schulzke House, Moline, Ill. (See illustration from photograph elsewhere in this issue)

It is a stucco house on wood frame. A heavy waterproof building paper was placed over the sheathing, then 2-in. by 2-in. furring strips were put on 12" o. c. The metal fabric is 24-ga., painted, ingot iron, expanded metal. On this three coats of stucco were applied. The first coat is put on thin to get a perfect key over the lath.

The second coat is a thin coat of cement plaster, and over this is placed a waterproof stucco thrown on with a paddle. This waterproof stucco is a commercial product made with crushed stone and waterproofed white Portland cement.[1] Mr. Schulzke says that the waterproofing is important in the stucco work because experiments have shown him that constant wetting and drying in ordinary cement stucco soon disintegrate it and cause trouble. Mr. Schulzke is a strong believer in the 2-in. by 2-in. furring strips rather than the thin furring strips in which dependence is placed on the building paper or the sheathing coming closer to the metal lath to key the plaster. He prefers to cover his lath by a careful application of the stucco and to have the additional air space which the 2-in. by 2-in. strips afford. He breaks up these air spaces by having occasional headers run across in the height of the work so as to stop the circulation of air. Mr. Schulzke says that the house is very comfortable both in winter and in the summer months.

Mr. Schulzke's house is very complete in many respects, although he plans an addition to give him a library and additional bedroom space, bath room and servant's room. The house is equipped with a vapor heating system and is piped for a vacuum cleaner plant. One ingenious device is in connection with the window boxes, which are watered by a pipe controlled from inside of the house. The house as it stands, the architect reports, cost $6,500.

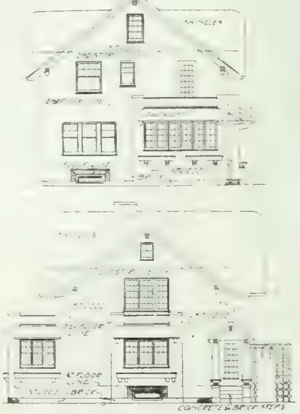

Fig. 2 Front and Side Elevations

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[1] Beder Woods, Moline, Ill., using Medusa cement of Sandusky Portland Cement Co., Cleveland, O.

An Architect's Own House With Concrete Walls and Floors

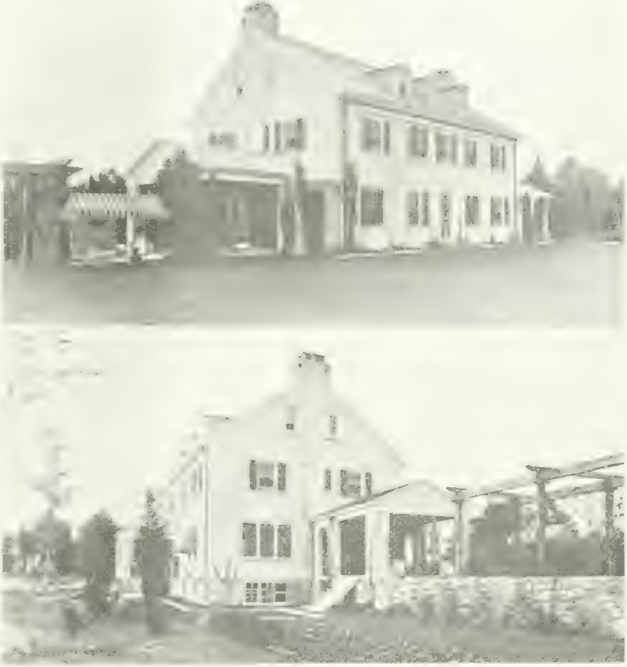
By Milton Dana Morrill

William A. Boring, architect, N. Y. C., selected reinforced concrete construction for his country residence at New Canaan, Conn., although a majority of the important works of the firm of Boring and Tilton have heretofore been carried out in brick and stone. They designed the great Immigrant Station at Ellis Island.

W. G. Wood, a progressive builder of Norwalk, Conn., had launched out into poured concrete for residence work, as he saw in this type of construction the greatest future. Mr. Boring watched the work going on and visited the concrete houses after their completion. He had to be "shown" and did not adopt concrete without due thought and consideration, and from cellar to garret in winter and summer he went through the houses which Mr. Wood had put up.

His friends, who knew nothing about it, told him that if he built a concrete house it would be damp, but fortunately he was in a position to judge for himself. He decided that poured concrete was the construction which he wanted, and as a result he has a permanent, fireproof house and he built it at a cost little in excess of that of the usual wood construction.

The plans here shown need little explanation, and the illustrations from photographs give one a good idea of the exterior design. As time goes on the house will become more and more attractive, as the trees, shrubs and vines, which Mr. Boring included in the architectural design, mature.



Figs. 1 and 2—Two Views of William A. Boring's House, New Canaan, Conn.

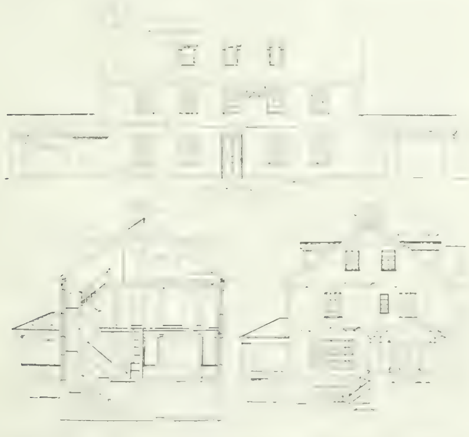


Fig. 3—Front and Side Elevations and Section, Boring House

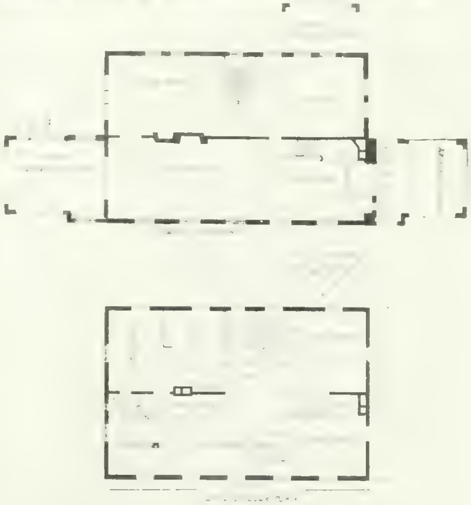


Fig. 4—First and Second Floor Plans, Boring House

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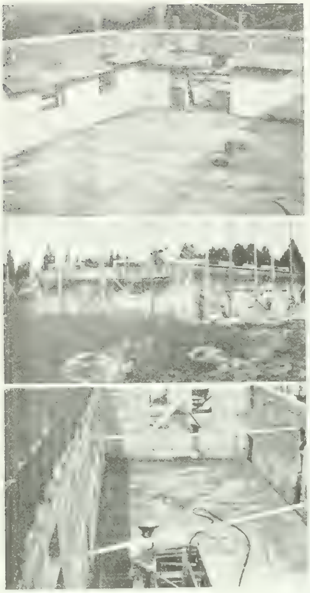
[1] Archt., Washington, D. C.



Figs. 5, 6 and 7—Construction Views, Boring House

At top, lifting a tier of wall plates; center shows window frames set in forms; bottom view shows offset for second floor bearing.

The house is of concrete throughout. The walls are 9″ thick in the first story, 7″ in the second, and 6″ in the third, with reinforcement, generally of 3/8-in. rods 24″ o. c. The partitions are of concrete 6″ and 4″ in thickness. Both walls and partitions were poured by the use of steel forms[2]; the floors are of reinforced concrete of the floor-tile construction.[3] The slab thickness between the concrete beams is 2″. Beams are 8″ deep, spaced 20″ o. c. The house has a shingle roof, which would appear to be the only vulnerable part. The walls were furred for lath and plaster.

There are many individual touches about the house which must be seen to be appreciated. Living room, hall and dining room are all finished in chestnut paneling, which extends from floor to ceiling, stained a deep brown. For the second floor construction the forms were made of heavy chestnut plank laid over heavy wood beams all rough-sawed; the concrete floor slab was put over this but the wood framing and beams were left as a finished ceiling, all stained a deep brown like the side wall paneling. The effect is very pleasing. Wherever in the house there is plastering a sand finish has been given and the tool marks and trowel marks have been left to give texture to the finish. Hardwood floors have been laid over the cement slabs, except in the kitchen and the servants' quarters, where the floors have been left with a cement finish. The exterior walls have a rough stucco finish of white Portland cement and sand.

Beside the house there is a garage and cow barn, all built of poured concrete inside and out.

The cost of the concrete in place, including all form costs, was about $6.50 per cu. yd.

Mr. Boring's house is a masterpiece of its kind. In its simplicity perhaps lies its greatest charm. One can picture how beautiful it will become as the years take off the new look and bestow that indescribable coloring and texture which time alone can give. It is also a modest example of the builder's skill in his desire and determination to improve his construction methods, and if only the public at large would realize what the real concrete house means this construction would take the place which it deserves as the best that can be built, regardless of price.

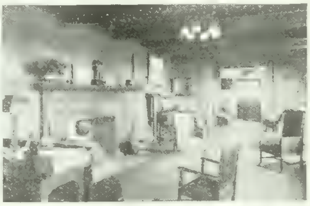


Fig. 8 -Living Room Boring House
Note Beamed Ceiling

Unfortunately, in this country we have become accustomed to building frame houses and about the only fire precaution taken is the fire insurance, which in no way prevents the tremendous yearly fire waste, but merely divides it among those who do have fires and those who do not. In the end the house owner pays the loss, anyway. The best way to insure is to build properly, and in a fire-proof material.

If we look at the ordinary frame house while it is building we can see that the woodwork looks almost "built to burn." If we wish to kindle a fire we space the pieces of wood much as the studs and beams are put together, and veritable flues are formed which cannot but spread the flames when once started.

Fig. 9—Cow Barn of Mr. Boring

Chicago Concrete Block House of Good Appearance

The development of the rock-face block in preference to other concrete units which are far more attractive architecturally cannot be attributed entirely to a belief on the part of the public that this is really an architecturally beautiful unit or to the fact that the block is commonly a successful imitation of a pitched face stone which was its model. A great deal of the preference for the rock-face unit is undoubtedly due to the fact that it can be laid up in the wall with less care and by less expert masons than a plain block which must be laid carefully in order not to produce a hideous result. The rock-face block and the other units with recessed joints can be laid with less care simply because the joints themselves, due to the projecting faces, are not so obvious.

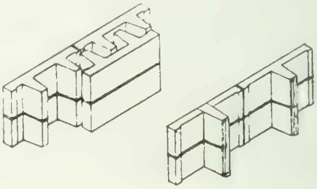


Fig. 1 —Detail Showing Two-Piece and One-Piece Block Construction

The accompany illustrations from photographs show attractive walls of concrete block and we feel sure that the pictures do not do the wall justice because they cannot begin to indicate the texture of the unit which was used in the construction. This is the residence of A. G. Carlson, at 72nd and Paxton Sts., Chicago. The texture, color and general effect of the units used in this work have the quality of granite and it is said that the work is commonly mistaken for granite. The trim is of white concrete stone.

This magazine has described the methods used in the manufacture of

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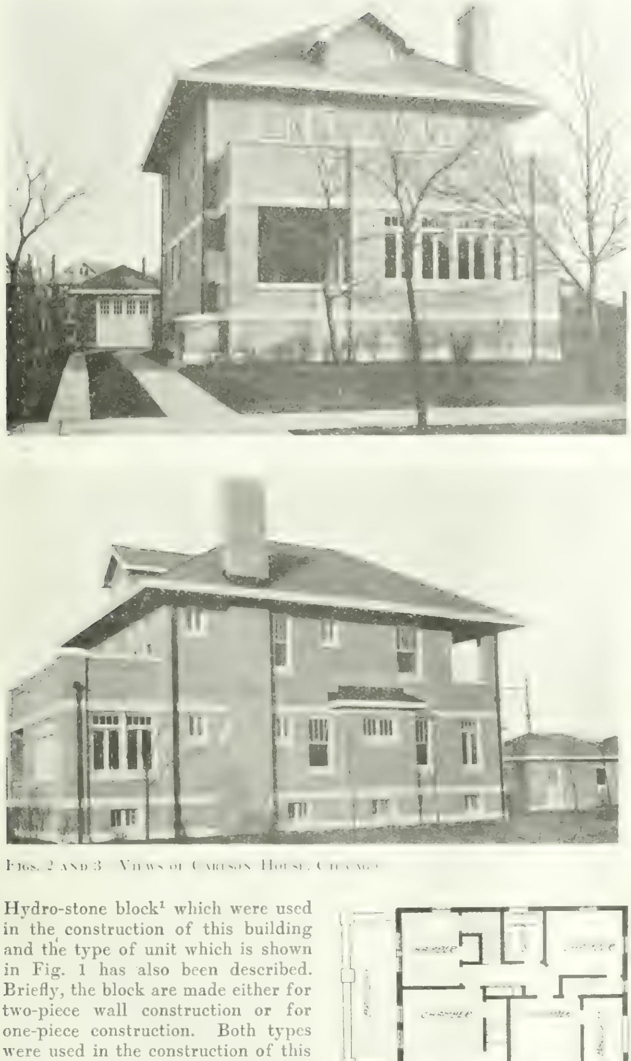
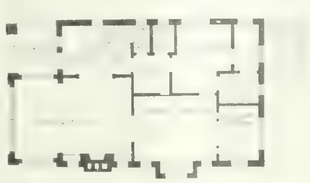
[2] Morrill system

[3] Trussed Concrete Steel Co., Youngstown, Ohio



Figs. 2 and 3—Views of Carlson House, Chicago

Hydro-stone block[1] which were used in the construction of this building and the type of unit which is shown in Fig. 1 has also been described. Briefly, the block are made either for two-piece wall construction or for one-piece construction. Both types were used in the construction of this house as required by the Chicago building regulations. The lower walls are of two-piece construction, shown at the left in Fig. 1, and the upper walls are of one-piece construction, as shown at the right. Inasmuch as the air space in the two-piece wall construction is continuous, interior plaster is applied direct to the block. With the one-piece construction the projecting lugs support furring strips on which lath of any kind is placed or metal lath may be applied direct to the lugs of the block without furring strips. If desired a building paper may be placed over the projecting lugs of the block with the furring strips and lath over the paper. The units are of a good proportion, 24″ long and either 12″ or 9″ in height. The concrete for these blocks is handled in a pressure machine. The mixture as used is ordinarily proportioned 1 part cement, $2\frac{1}{2}$ parts torpedo sand and $3\frac{1}{2}$ parts of gravel or stone up to $\frac{3}{4}$-in. size. Block are made face up and after the backing is put in and struck off the facing is applied. Mr. Carlson selected the facing to give a light gray granite effect. This was made of a mixture of Micaspar crystals,[2] Tuckahoe white marble and Universal Portland cement.[3] The trim in the lintel courses, cornices, window sills and copings is of a white granite quality made with the same facing materials except that Atlas White Portland cement was used instead of gray cement. The garage which is also shown in the rear of the residence in one of the illustrations was built of 8-in. two-piece block. The walls of the house and of the garage above grade were contracted in place at a price of $1,600, while the total cost of the house and garage, including very fine interior trim and numerous special features, was $7,800.



Figs. 4 and 5—First and Second Floor Plans

Oil and Portland Cement

While the ability of Portland cement to withstand the influence of oil has been many times investigated in a superficial way, the conclusions of Dr. Schumann, presented at the last meeting of the Assn. of German Portland Cement Mfrs., are of great importance, as they are based on a very careful and extensive study of this subject. These conclusions are as follows:

No. 1. The strength of cement was lowered to about the same extent by the action of petroleum, mineral oil and rape oil in cases in which the cement had hardened a sufficient time either in water or alternately in air and water.

No. 2. The denser the cement mortar or concrete the better its ability proved to be toward withstanding the action of oils.

No. 3. The rape oil proved to have the most deleterious effect on mortars and concretes.

No. 4. By using a mixture of 1 part cement to 1 part of sand, with careful workmanship and allowing the mortar to harden 1 yr. under water, the resulting surface is perfectly capable of resisting the destructive effects of oil, even when continually brought in contact with the same.

It is, of course, to be noted that animal or vegetable oils, such as rape oils, are destructive to cement on account of their property of combining with the lime of the cement to form lime soaps. Whenever an oil is likely to come in contact with mortar or concrete special effort must be made to secure a dense, impervious surface.

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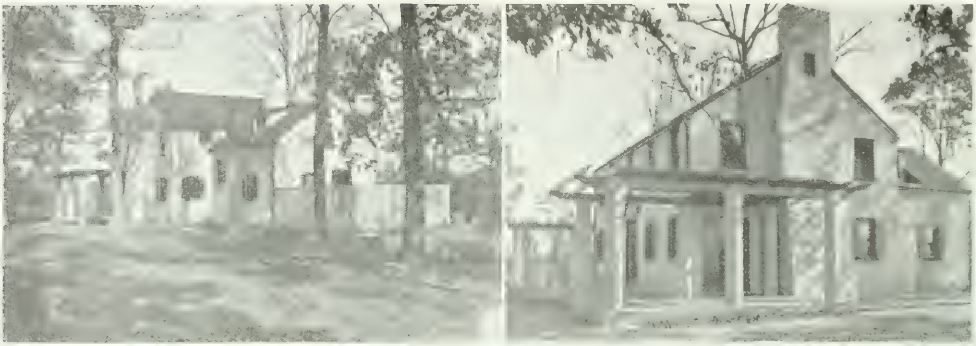
[1] Barron & Harridge, Chicago

[2] Crown Point Spar Co., Crown Point, N. Y.

[3] Universal Portland Cement Co., Chicago



FIGS. 1 AND 2 TWO VIEWS OF HOUSE OF MR. MASSEY AT MIDDLEBURG, VA.

Two Houses of Poured Concrete Erected at Middleburg, Va.

Interesting work in the construction of concrete houses built at Huntland, the estate of Joseph B. Thomas, near Middleburg, Va., will be remembered by readers of CONCRETE. Descriptions of some of this work were published in this magazine two years ago and again a year ago[1] when the construction was in charge of the late Claude H. Haga, and later Mr. Haga was assisted by Milton Dana Morrill.

The accompanying plans and illustrations with data as to construction are presented through the courtesy of Mr. Morrill, and while the construction is not on the Thomas estate but at Middleburg for other owners, construction which is similar to the work at the Thomas estate is described.

Plans and illustrations from photographs shown herewith are of residences for G. Gordon Massey and for E. W. Murphy. The poured concrete walls of these houses have a thin stucco finish. The floor and the roof construction in both cases is of frame.

The house for Mr. Massey was designed by Milton Dana Morrill and built by Claude H. Haga, contractor. The foundation walls are of concrete with field stones bedded in the mix, the thickness of the walls being 12″. The walls above the second floor level are 8″ in thickness. The reinforcement is horizontal only, with but from two to four rods of 3/8-in. size put in over openings in the wall. The concrete used was a 1:2:4 mix, the stone used being obtained from field stones crushed on the job. The walls are furred for lath and plaster and in order to have nailing places for the furring small wood nailing blocks were dropped in each day as the work progressed. Each of these blocks had a nail driven into it part way and the blocks were dropped in 16″ o. c. with the nail projecting down into the freshly placed concrete to hold them in position next to the inner form. The exterior walls were covered with a thin coat of stucco mixed with Atlas white cement[2] and sand in equal proportions. The porch is set in concrete tile. The entire house cost approximately $7,000.

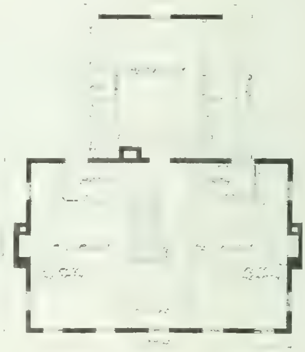


FIG. 4—SECOND FLOOR PLAN, MASSEY HOUSE

The house for Mr. Murphy was designed by Mr. Haga and the work was finished under the direction of Mr. Morrill after Mr. Haga's death. The walls, as in the case of the Massey house, are 12″ thick. Here the partitions are 8″ thick. The only re-

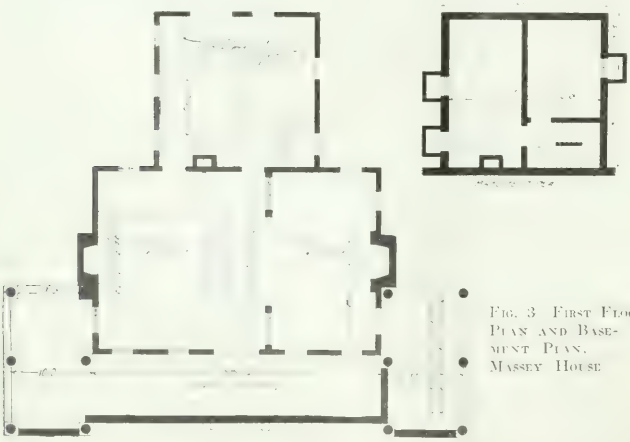


FIG. 3 FIRST FLOOR PLAN AND BASEMENT PLAN, MASSEY HOUSE

inforcing is ½ in. rods placed over windows and doors, horizontally. Reinforced slabs were used over the porches at each end of the house. Elsewhere the usual wood joist construction was used in the floors. This house was given a stucco finish, thin like that on the Massey job, but after this had been put on it was washed down with white cement and water which was tinted with ochre to give the walls a mellow tint. There was an old stone house on the Murphy house site and the old stone was crushed and used in the new building. Field stones were also utilized in making the concrete. Interior walls were furred for lath and plaster and pipes were placed in spaces formed by the furring. All radiators are concealed in recesses under the windows, this being possible owing to the very thick walls. A construction of this kind, while not ordinarily economical in such great wall thickness, was felt by both Mr. Morrill and Mr. Haga to be so in this case, due to the experience which they had had in building houses on the Thomas estate. It was found that with thick walls, where it was possible to bed a large amount of field stone in the concrete, it was just as cheap as thin walls which had to be heavily reinforced.

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[1] Jan., 1914, and Feb., 1915

[2] Atlas Portland Cement Co., N. Y. C.

On both of these jobs the forms were handled in such a way as to use two tiers of forms, or a total form height of 4′, and pour one tier a day. The lower forms were taken off each morning and swung up on a frame so that they were handled together in long strips and in the new position were filled again. Thus the two tiers alternated every two days. The concrete was handled in wheelbarrows to 4′ above grade. Above this height pails were used as far as the second floor level, the pails being handled in wheelbarrows four at a time and taken to different parts of the building and passed up to the tops of the forms by hand. Above the second floor level the pails were hooked to a grapple four at a time and raised to the form level by a drum on the mixer. They were then carried by hand. No staging was necessary, as the floors followed the walls, nor was any staging or outside scaffold used in handling the forms. The average labor cost for cleaning and fitting the steel forms was 1 ct. per sq. ft. of form surface or 2 cts. per sq. ft. of wall. In both cases the exterior stucco finish was put on about 60 das. after the walls were up. The stucco is very thin, in some places not more than ⅛″ thick. The illustration of this stucco surface shown elsewhere in this issue indicates slight crazing but this view is from a photograph taken at very close range and owing to the rough texture the crazing is not objectionable, in appearance at least, and it is believed that the walls are so nearly waterproof in themselves as not to need the stucco as a seal coat. Stucco put on in this same way more than three years ago shows no signs of peeling. It is only with very true forms and smooth cast surfaces that it is possible to use so thin a stucco to smooth up a wall.

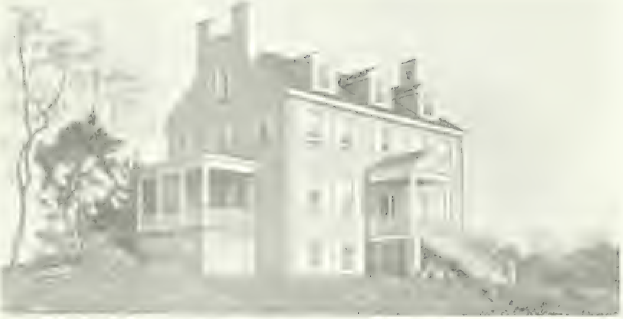
Fig. 5—House of [illegible] Murphy at Middleburg, Va.

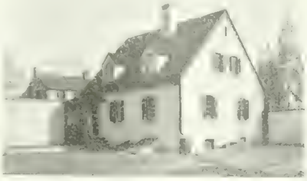
Fig. 7—Rear View of Wall Cottage at Huntland, Estate of J. B. Thomas, Middleburg, Va.

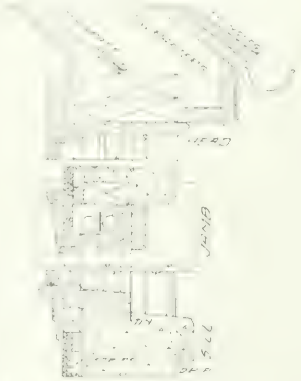

Fig. 8—Details Window Frames and Cornice, Massey House

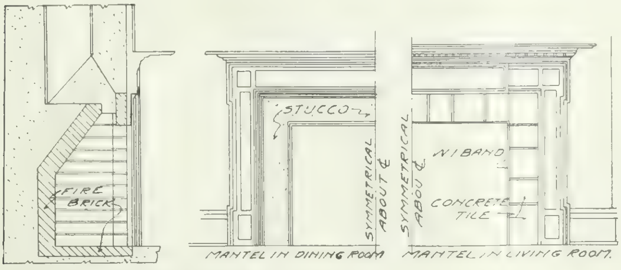

Fig. 6—Fireplace Details, Massey House

An echo of the war appears in the notice just issued to the members of the Internatl. Assn. for Test. Mat. Dr. Reitler signs the circular, which says: "The war has interrupted the activity of the Association. We have therefore for months been obliged to confine ourselves to the bringing of the work of the Sixth Congress to a conclusion by issuing a reprint of the Uniform Nomenclatures recommended by this Congress. As the Association has sufficient funds to cover the administrative expenses for a long time, we beg to inform you that no member will be called upon for payment of his dues until the Council, after the change of the political situation, take further action. But non-payment will in no way interfere with membership."

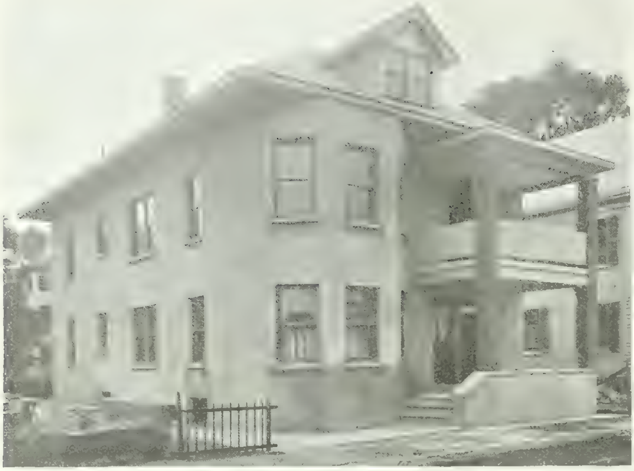

Fig. 1—Two-Family Concrete House at Salem, Mass.

Typical Two-Family House Complies With Salem's Strict Building Code

By C. D. Gilbert

A conflagration of the proportions of that at Salem, Mass., turns the attention of the home builder to fire-resisting maerials. Salem has "come back" in a way that reflects credit on her people. Needless to say, the present building code provides rigid restrictions designed to prevent the spread of future fires. Some of the provisions respecting residence construction are:

1. The abolition of shingle and composition roofing, with the requirement that all cornices and dormers shall be covered with fire-resisting material.
2. Provision for exceptionally efficient fire stopping of frame walls and partitions.
3. Provision for ample stairways and insulation of heating apparatus and chimneys.

While the provisions adopted by the building commission seem to some to work hardship, a study of modern building materials and methods has demonstrated that the comparatively small outlay required to comply with the law is really an economy due to greater permanency.

The result of forced building operations and the efforts of those interested in furnishing building materials was to give the people of Salem an unparalleled opportunity to study modern construction materials. A trip through the city reveals almost every type of residence construction.

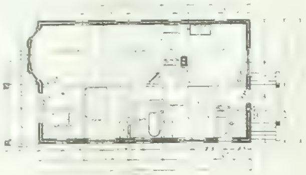

Fig. 2—First Floor Plan

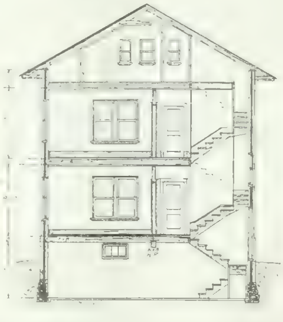

Fig. 3—Section at A-A Through Rear Hall

GENERAL FEATURE

The house described in this article contains a number of interesting construction details. The outer walls are of concrete of what has become popularly known in Salem as thermos bottle construction. This consists of double reinforced concrete walls separated by a $2\frac{1}{2}$-in. air space erected with a hollow wall machine,[1] but the interior is of frame construction. The front and the rear porch are of concrete. The cornice is of stucco on metal lath, the roof structure of slate on frame. The chimney is of concrete with a square vitrified clay flue lining.

An inspection of the plans will show that the house is a typical two-flat building, each flat containing five rooms and bath, while provision is made for two extra rooms and storage space in the attic. The house is equipped with a steam heating plant, the owner heating both flats. Electric lights are used and gas is piped to the kitchen, although provision is also made for a coal range. The floors and the trim are of selected North Carolina pine.

CONSTRUCTION

As this house was built on the site of a burned structure there was a considerable amount of stone from the old walls available in the excavation. It was decided, therefore, to make use of these stone and the old walls were tumbled into the middle of the cellar and the excavation trimmed to a proper size. The first floor joists were utilized as forms and set up one plank high at a time around the excavation. Concrete was then deposited back of the forms and the stone were carefully bedded in the concrete. Other planks were added as needed until the stone available was entirely used, which made a solid wall 2′ wide at the base and about 3′ high. On top of this rather massive footing the double wall construction was started with the hollow wall machine. A 4-in. inside wall and a 6-in. outside wall was used for the remainder of the basement so as to provide a water table (Fig. 3.) When doing this part of the work, owing to the stone piled in the cellar and to obstructions on the surface of the ground, it was impossible to handle concrete by means of wheelbarrows. A wire cable was therefore hastily rigged over the excavation as a miniature cableway system and heavy galvanized buckets attached to the trolley were readily carried practi-

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[1] Van Guilder Hollow Wall Co., Rochester, N. Y.

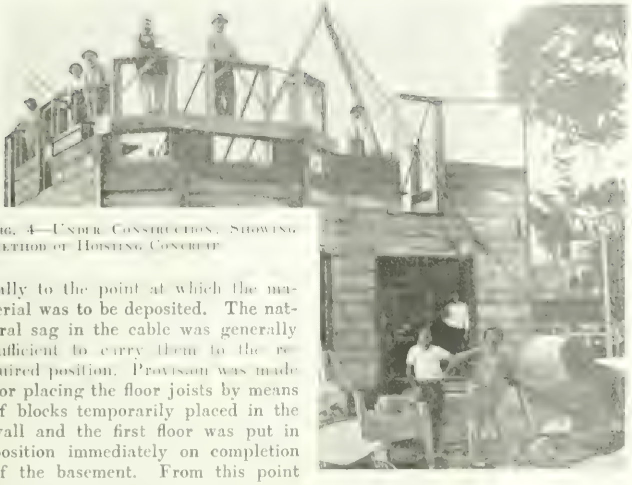

FIG. 4—UNDER CONSTRUCTION, SHOWING METHOD OF HOISTING CONCRETE

cally to the point at which the material was to be deposited. The natural sag in the cable was generally sufficient to carry them to the required position. Provision was made for placing the floor joists by means of blocks temporarily placed in the wall and the first floor was put in position immediately on completion of the basement. From this point the concrete walls were in two 4-in. sections.

HANDLING CONCRETE

Concrete for the first story was handled by means of a runway by which it was wheeled in pails to the floor and passed to the staging, to be placed in the walls. On this class of work it is found that it is cheaper to handle concrete in buckets than to provide the necessary runways for wheeling small quantities widely distributed. After the first floor was in, a wire cable was rigged from the mixer over an A frame on the second floor and 3 buckets hoisted at a time by means of a small gasoline hoist which was a part of the mixer outfit.[2] The building was staged by means of 3-ft. saw-horses, substantially made, and these were used again on subsequent work. The second stage was provided by means of extensions which were put on the horses and made secure by means of light stays. This arrangement permits rapid and very economical work. The second staging is high enough to complete a story height.

Concrete Material The aggregate available was bank-run sand and gravel. The quality and grading were not all that could be desired, but a 1:5 mix resulted in an excellent concrete.

PORCHES

The front and the rear porch are of concrete, but brick columns were used in front to add a touch of color to the building. The porch walls were built with the wall machine and a plain cap used as finish. Brick on edge at window sills give another color note. All porch floors and steps are of concrete. A detail of the form work and reinforcing for the front second floor porch is shown. Reinforcement consists of 2 ¾-in. rods, trussed, in the beam and ½-in. rods 16″ c. to c. each way in the slabs. This reinforcing seems excessive but consisted of scrap rods of doubtful quality, which were available at low cost. The porch roof was designed to be of reinforced concrete, but was changed to frame construction with cornice and ceiling of metal lath. It is believed that had the original plans been carried out the roof would have been more permanent without being any more expensive. This roof is covered with tin and drained through one of the brick piers. The second floor porch slab was waterproofed with a layer of pitch between the structural slab and the top surface.

DETAILS

The chimney, which contains two 8 x 12 flues, is built of concrete. Two sets of forms 3′ high were made substantially as is a column form, and filled each day. As each 3-ft. lift was added the forms below were taken off, to be used again higher up. The vitrified flue linings acted as the inside form. Reinforcement was used, consisting of odd lengths of wire and iron forming hoops at intervals of about 1′. Chimney construction kept pace with the walls and was very economical. Brick was used above the roof, making a more convenient means for flashing and worked out well with the brick porch columns and window sills. Bearing partitions were fire stopped with concrete at each floor level according to the building code, being filled solid from the girder or partition cap on which they rest to a point 5″ above the floor level. The same fire stopping is required at each floor level in walls of frame buildings. Cornice construction, as shown by the details, is of a metal covered fascia and a metal lath and plaster soffit. The method of making a satsifactory joint between the concrete wall and the metal lath is indicated by the details. The exterior finish consists of two coats of cement mortar and a rough-cast finish.

The inside plastering was done directly on the concrete walls, which are thoroughly insulated by the air space. The two dormers are of frame construction, the sheathing being furred and covered with metal lath. The metal lath extends to the roof sheeting so as to form a fire stop at that point. The roof was covered with a good quality of green slate.

The window frames were of special design and would be economical when made in quantities, although a premium was paid for those used on

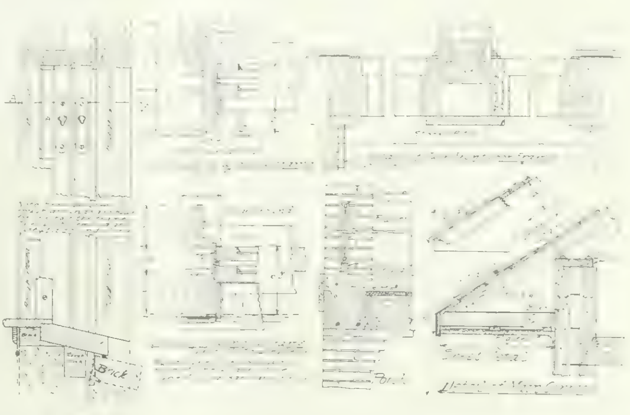

FIG. 5—DETAILS

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[2] Jaeger Machine Co., Columbus, Ohio

this particular house. As will be seen by an inspection of the details, the kitchen, bathroom and rear halls were not provided with the usual window trim; instead, a rough triangular strip was used which formed the concrete into such shape that the plasterer was able to form rounded sanitary trim. Throughout the remainder of the house the usual type of trim was placed as shown by the detail. Pullman balances[3] were used, which did away with the necessity for box frames. The balances are protected from the concrete by means of pressed steel housing which is supplied for concrete work. This balance is very effective and does away with weights and cord.

COST

In considering the cost of this house it must be remembered that no one connected with the job except the foreman had had previous experience with the machines used or with concrete construction. The workmen employed had been previously engaged in another line of work. It is not surprising, therefore, that under these circumstances the costs were somewhat more than would be the case in duplicating the house, although these conditions were partially offset by the low cost of labor. The builder itemizes the cost as follows:

Surveying	$ 25.00
Labor, including excavating, concrete and rough carpentry	1.294.11
Cement, sand, lime, hair	413.79
Lumber and millwork	1.497.48
Brick work	46.70
Plastering	402.79
Siding and sheet metal	220.63
Doors and windows	150.15
Window balances	52.70
Finished carpentry labor	384.00
Plumbing	424.55
Heating	313.47
Electric wiring	71.00
Electric fixtures	58.70
Painting	205.00
Hardware and sundries, as reinforcing wall ties, gasoline, flue-lining, express, bookkeeping, telephone, carfare	339.97
Total	$5,900.00

The house was built by P. Creedon, Salem, for T. J. Maroney. It was designed by the author and erected under his direct supervision.

A New Use for a Dishpan

A novel light was recently observed in use on a construction job. A bright tin dishpan was mounted on a wood frame and acted as a reflector for a cluster of electric lights.

The whole contrivance was suspended from a derrick boom and was very effective in lighting the work as handled by the derrick. This is a makeshift, of course, and was used only because suitable lighting equipment was not available exactly when it was wanted.

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[3] Pullman Mfg. Co., Rocheter, N. Y.

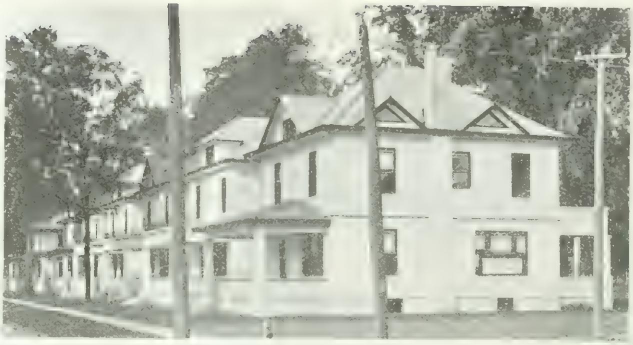

Fig. 1. A Group of Attractive Poured Concrete Houses

A Group of Concrete Houses Erected at Newark, Ohio

By George V. K. Greene.[1]

Following is a brief description of all-concrete dwelling houses erected by Eli Hull, at Newark, Ohio. Mr. Hull has developed an entire city square with fireproof houses. In the center he has erected a concrete community garage to conform, architecturally, with the houses. This garage, although under one roof, has a private room for each of the tenants of the house.

Mr. Hull, although a man of 87 years, has undertaken to show the people of the Middle West the advantages of living in an absolutely fireproof house.

These houses were cast in the Lambie[2] forms, one complete story at a time, including the floor and the partition walls. Window and door frames are cast in and are perfectly weather-tight.

The houses contain eight rooms and a bath and are heated by hot air

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[1] Chf. Eng. Lambie Steel Form Co., N. Y. C.

[2] Lambie Steel Form Co., N. Y. C.

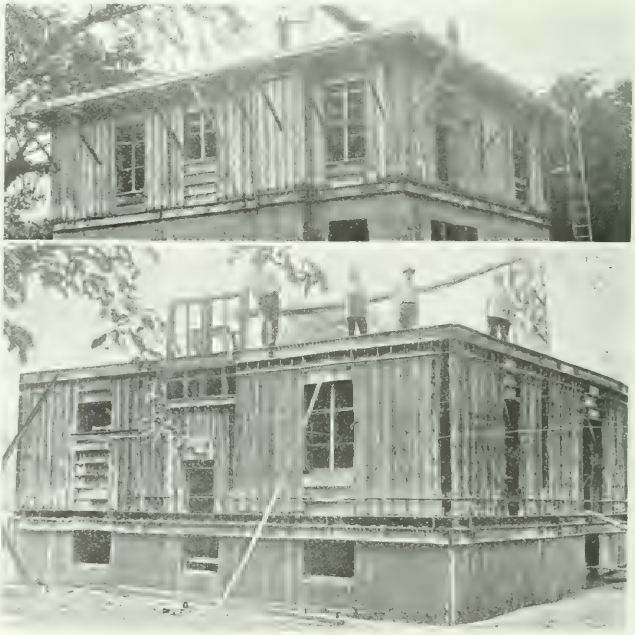

Fig. 2. Form in Place for Pouring First and Second Story

furnaces, the hot air ducts being cast in the walls. The usual light gauge metal ducts were used and they were filled with sand to keep them from collapsing. After the forms were removed this sand was allowed to run out.

Six-in. reinforced concrete walls and partitions were used from the footings to the cornice. The mix was 1 part cement and 6 parts of aggregate as it came from the river bed. The aggregate was clean, sharp sand and gravel and was so close to the necessary proportions that it was not screened, but was used as it came on the job.

The walls are reinforced with ½-in. round rods, 18″ o. c. each way. The same reinforcing was used in the floors 9″ o. c. the short way of the span and 2′ the long way. These rods also acted as tie-rods to hold the forms in place. A part of the floor reinforcing in both directions was carried through the belt course plates by ½-in. x 2-in. bolts attached to the rods by cast iron sleeve nuts. This permits leaving on the belt course plates when the wall plates are removed, and they are used as a gauge to hold the wall plates in position for the floor above, thereby holding them rigidly in place without further bracing.

The floor plates rest upon an adjustable beam, which in turn rests upon and is bolted to a ledger angle. This ledger angle fits into an L-shaped notch near the top of the plate, leaving the space below clear of braces. See Fig. 2, which also shows the second floor being cast and the method of casting the cornice without long braces. A 2-in. x 4-in. stick was cast in each belt course, both front and rear, to form a slot so that the floors of the porches could be tied to the main building. The necessary soil and gas pipes and electric conduits were cast in place.

An average time for setting up a story was less than 3 das. and not more than 7 men were employed at one time. All concrete was machine-mixed and hoisted in a tower and carried by spouts to the forms. The stories contain from 30 cu. yds. to 34 cu. yds. of concrete. It took from 5½ hrs. to 6 hrs. to pour each story. Stripping and cleaning forms took about 2 das., a total of about 1 wk. for each story. The 70-ft. tower was placed so that it could take care of four houses.

The roof frames are of 2-in. x 6-in. spruce, nailed to a 2-in. x 6-in. plate, secured to anchor bolts cast in the cornice. The roofs are covered with different colored asbestos shingles.[3]

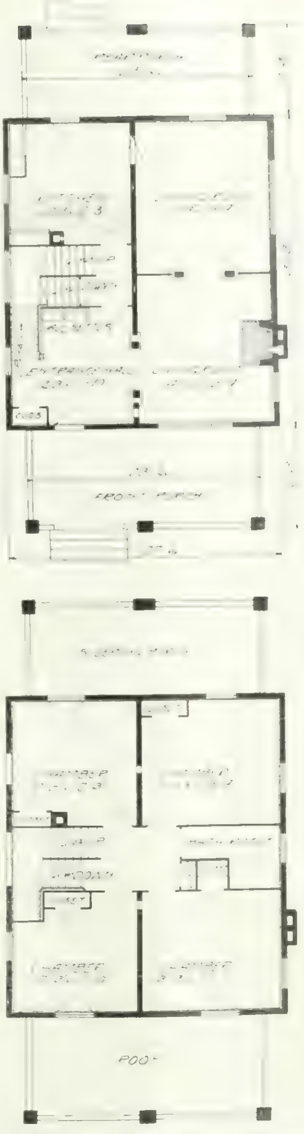

Fig. 3 Floor Plans of Newark Houses

The houses are finished with a fine stucco of white sand put on by the "Swenson" stucco machine.[4]

The interiors are finished in oak. The floors are of comb-grained pine nailed to sleepers cast in the concrete floors.

Note the difference between house No. 1 and house No. 2 after the men had become used to the handling of the forms. The writer has been informed that these houses have been completed for less than $2,500, cost including heating, plumbing and lighting. Note the cost per sq. ft. of forms in labor, also cost of concrete in place. Gravel, it must be noted, was delivered for 60 cts, per cu. yd.

House No. 1, at Newark, Cost

[illegible]		
[illegible]	$ [illegible]	
[illegible]	[illegible]	
	$ [illegible]	
Charge ⅛ of this to each house....		$ 2.13
[illegible]		
[illegible]	$ [illegible]	
[illegible]	[illegible]	
	$ [illegible]	
Charge ¼ of this to each house...		$ 15.19
Excavation:		
147 cu. yds. at 19½ cts.....	$ 28.67	
Footings and Cellar Floor:		
Labor: 20 hrs. at 25 cts.....	$ 5.00	
Materials:		
5 bbls. of cement at $1.45 del.	7.25	
12 cu. yds. of gravel at 60 cts. del.	7.20	
	$ [illegible]	$ [illegible]
Setting Forms for Basement (3,266 sq. ft.):		
Labor:		
126 hrs. at 22½ cts.......	$ 28.35	
18 hrs. at 45 cts.........	8.10	
		$ 36.45
(Cost per sq. ft. of forms in place $.0112)		
Reinforcing:		
1,420′ ½ in. round rod at 1 ct. per ft.	$ 14.20	
Labor: 7 hrs. at 22½ cts....	1.58	
		$ 15.78
Concrete: 34 cu. yds.:		
50 bbls. cement at $1.45.....	$ 72.50	
34 cu. yds. gravel at 60 cts..	20.40	
Labor:		
18 hrs. at 45 cts...........	8.10	
45 hrs. at 22½ cts.........	11.13	
		$[illegible]
Gasoline, water and oil............		1.75
(Cost per cu. yd. of concrete in place $3.34)		
Stripping and Cleaning:		
54 hrs. at 22½ cts.................		$ 12.15
Recapitulation:		
Labor and materials........	$177.26	
[illegible] of carriage..........	[illegible]	
[illegible] of tower	[illegible]	
	$183.03	
Excavation	[illegible]	
Footings	[illegible]	
		$[illegible]
(Cost of concrete in basement $5.34 per cu. yd.)		

Labor and Material, 1st Story.

Setting of forms, 1st story (3,444 sq. ft.)		
Labor:		
40 hrs. at 45 cts...........	$ 18.00	
88 hrs. at 22½ cts.........	19.80	
		$ [illegible]
(Cost per sq. ft. $1.09)		
Reinforcing:		
1,460′ ½ in. round rods at 1 ct. per ft	$ 14.60	
Labor:		
6 hrs. at 45 cts............	2.70	
6 hrs. at 22½ cts..........	1.35	
		$ [illegible]
Concrete (30 cu. yds.):		
Material:		
Cement, 44 bbls. at $1.45...	$ 63.80	
Gravel, 30 cu. yds. at 60 cts	18.00	
Labor:		
36 hrs. at 22½ cts.........	8.10	
12 hrs. at 45 cts...........	5.40	
		$ [illegible]
Water, gasoline, oil, etc...........		1.75
(Cost of 1 cu. yd. of concrete $3.23)		
Stripping and Cleaning Forms:		
Labor:		
48 hrs. at 22½ cts.........	$ 10.80	
6 hrs. at 45 cts...........	2.70	
		$ [illegible]
		$167.00

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[3] Keasbey & Mattison Co., Ambler, Pa.

[4] Swenson Automatic Stucco Mach. Co., N. Y. C.

RECAPITULATION:		
Labor and material, 1st story	$167.00	
⅓ of cartage	.71	
⅓ of tower	5.06	
Cost of first story		$172.77
(Cost of 1 cu. yd. of concrete in place $5.77)		

Second Story.

SETTING UP FORMS second story		
3,647 sq. ft.		
96 hrs. at 22½ cts.	$ 21.60	
72 hrs. at 45 cts.	32.40	
		$ 54.00
(Cost per sq. ft. $.0148)		
REINFORCING:		
1,538′ at 1ct. per ft. (½-in. rod	$ 15.38	
16 hrs. at 30 cts.	4.80	
		$ 20.18
CONCRETE—38 CU. YDS.:		
56 bbls. cement at $1.45	$ 81.20	
38 cu. yds. gravel at 60 cts.	22.80	
Labor:		
28 hrs. at 22½ cts.	6.31	
21 hrs. at 45 cts.	9.45	
		$119.76
(Cost per cu. yd. $3.15)		
REMOVING FORMS:		
96 hrs. at 22½ cts.		$ 21.60
RECAPITULATION:		
Labor and material, second story	$215.54	
⅓ cartage	.71	
⅓ tower	5.06	
		$221.31
(Cost per cu. yd. in place $5.81)		

TOTAL CONCRETE COSTS:

Cost of concrete work	$625.23
Window frames	60.00
Electric conduits and boxes	20.00
Flues	4.00
Soil pipe	4.00
Sleeve nuts	9.00
Incidentals	6.00
	$728.23

(102 cu. yds. in building).

NOTE 1.—This does not include charge for investment in forms or overhead.

NOTE 2.—House No. 2 cost, at the same point, $684.65, a saving of $43.58, due to experience with the forms.

When building forms it is well in many places to nail through a bit of lath. This allows the forms to be drawn tight and when wrecking the lath may be split, allowing the nails to be drawn easily.

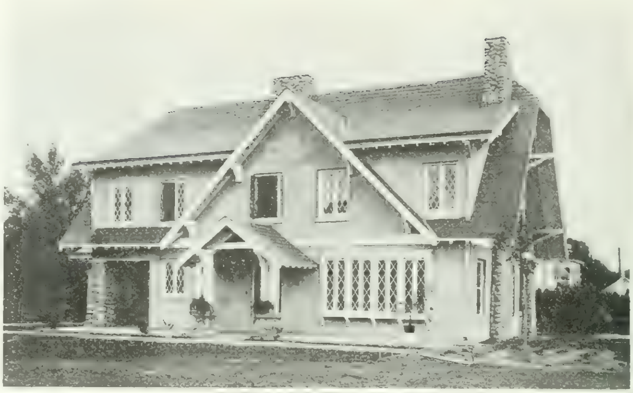


FIG. 1—RESIDENCE OF L. WILLIAMS AT WACO, TEXAS

Concrete, Boulders and Casements, Features of Waco House

The belief that still lingers in the minds of many otherwise well informed persons, that a concrete house must be of stern and forbidding appearance, would be forever dispelled by a visit to the residence of L. Williams at Waco, Tex.

This attractive residence, which was designed by Edward H. Reed[1] and built by Harris & Hewitt,[2] is far from looking severe or cold. Its cost was moderate. The plans show a basement, which contains a large den in addition to the rooms for the heating plant. The first floor provides large living room and dining room, reception hall and kitchen. On the second floor are three bedrooms, a sewing room and a bathroom.

CONSTRUCTION

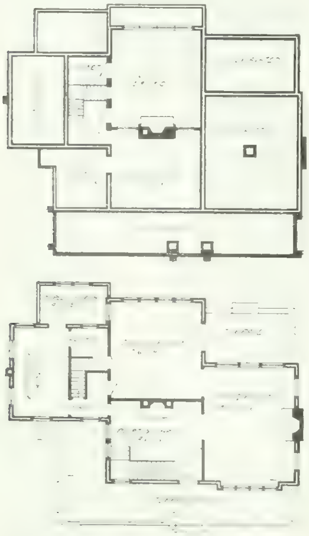
The walls are of hollow monolithic concrete construction from basement to roof. They were constructed without forms with a hollow wall machine.[3] This machine consists essentially of a box-like piece of equipment about 5′ long provided with a collapsible core and in use is placed in position on the footing; then the wall chambers are filled with concrete of just such consistency that it will not sag when the machine is released. Having filled the machine, a single movement of the lever releases it from the wall and it is instantly pushed ahead and again filled. This operation is repeated around the wall, when it is generally found that the first course has hardened sufficiently to bear the weight of the light machine and another layer can be immediately placed. Suitable provision is made for reinforcing and for placing window and door frames and for all other construction details. The walls as left by this process are rough, no attempt at finish being made during their construction. They are, however, an ideal surface for the application of plaster and stucco.

The exterior of the house is finished in Portland cement stucco and the interior is plastered direct to the concrete wall, without fear of dampness, owing to the double construction.

The builders have itemized the cost of the house, exclusive of the slate roof and oak floors, which were furnished under separate contracts. These costs are based on the following wage scale: Plasterers, 87½ cts. per hr.; painters, 50 cts. per hr.; laborers, 25 cts. per hr.; carpenters, 50 cts. per hr.

DETAILS OF COST

Excavating	$ 258.40
Concrete walls and footings	1,088.80
Brick and cobble stone	500.00
Plaster, stucco and concrete floors	1,402.00
Tile for bath room	54.00
Iron	38.00
Wiring	167.00
Tin and heating	489.00
Hardware	200.00
Labor on carpenter work	1,465.00
Mill work and labor	1,390.00
Lumber	1,235.00
Painting	700.00
Plumbing	600.00
	$9,588.20



FIGS. 2 AND 3—BASEMENT AND FIRST FLOOR PLANS, WACO HOUSE

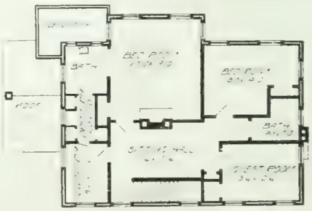


FIG. 4—SECOND FLOOR PLAN, WACO, TEXAS HOUSE

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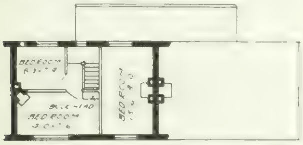
[1] Architect, Waco, Tex.

[2] Contractors, Waco, Tex.

[3] Van Guilder Hollow Wall Co., Rochester, N. Y.

English Rural Two-Family Cottages of Concrete Block and Stucco

The accompanying illustrations show concrete block two-family cottages built in Kent, England, for the Crayford Cottage Society, under the direction of the Rural Housing Organization, on an estate which is being laid out for nearly 500 cottages and for several public buildings.[1] The estate will also provide for recreation grounds, village green, bowling green and various other open spaces. The site adjoins the river Cray and is close to the village of Crayford. The construction work is being done by the Cottage Construction Co., London. So far cost comparison between brick work and concrete block work shows results greatly in favor of concrete block. While practically all of these houses are similar in plan, they are varied a great deal in the elevation to avoid monotony. Each dwelling has a frontage of 24′ 4½″ and a depth of 17′ for the main building, with a projection of 6′ for a total length of 12′ at the rear of the ground floor. The accommodation on the ground floor consists of a living room, 16′ 6″ x 11′, a parlor 12′ 4½″ x 9′, a scullery, bath and larder and fuel store space and on the first floor there are three bed rooms, the largest being 15′ 6″ x 9′ and the smallest 8′ 3″ x 7′ 9″. Each floor has a height of 8′. The arrangement is shown in the accompanying plans. The contract price per cottage built with concrete block without any extras is from £175 to £179, or from about $850 to $870, while the cost of brick cottages of the same plans was about $60 more than this per cottage. The extras, which are not included in this price, refer to gable and pitched roof changes, necessary to secure external variations.



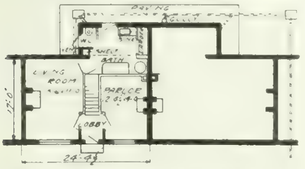


Fig. 2—Second Plan, Crayford House

Fig. 3—First Floor Plan, Crayford House

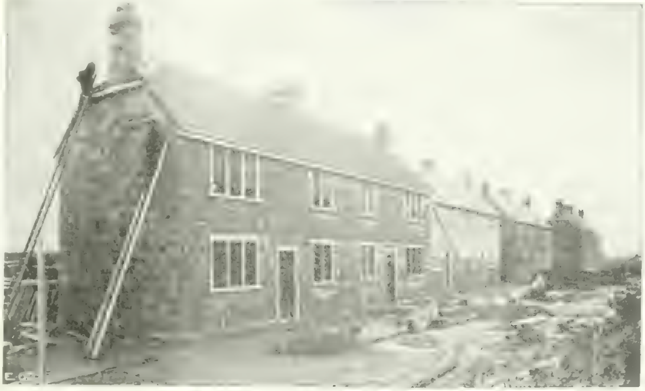


Fig. 1—Concrete Block House Under Construction at Crayford, Kent, England

In the construction of these houses concrete block made on a standard dry-tamp machine[2] were used. The block are 9″ x 9″ x 16″ and are made from the mixture of 1 part cement to 5 parts gravel, material all passing a ¾-in. mesh. The block are allowed a curing period of 14 das. and so far extremely wet weather has made sprinkling unnecessary. The interior partitions are built with cinder concrete slabs 2¾″ thick made on the same machines as the concrete block. Chimney flues and stacks are also built of block, special block being molded for flues. Gables are finished at the top with block having a splay to fit to the roof. The second floor is of ordinary wood joist construction boarded on top and plastered below, while the ground floor of concrete is finished with boarding nailed to sleepers inserted in the surface concrete. The exterior surfaces are plastered with a mixture of cement, sand and waterproofing and finished with rough-cast. This surface stucco is depended upon to keep out moisture, as the block themselves are not made with the idea of resisting percolation, although they are plenty strong enough for the construction. All interior wall surfaces are plastered except those in the scullery. These surfaces are covered with a water paint.

A sarcastic writer who signs himself "A Building Inspector" writes to the Arlington, N. J., *Observer,* asking "the town building superintendent or architect of the building or the contractor of a building on a certain street in Arlington to furnish through the columns of the paper his data for use of mud concrete in building foundations." The writer goes on to say: "As this is somewhat of a new departure in the building line, information is desired as to the proportions of ingredients used, the values in compression, tension, thrust, etc., for both plain and reinforced concrete and any other data available about the use of mud as a concrete ingredient." The tale may be told when a concrete failure is reported if the facts as intimated are true.

"Concrete for permanence" as well as "for safety first" may be again used as the text in connection with the recent construction of concrete buildings by the Shreve Chair Co. at Union City, Pa. These buildings, three in number, were erected to replace other edifices twice destroyed by fire. One of them is 400′ by 86′ and the other two about 120′ by 50′ and 150′ by 40′. As as result of this changed construction from the old mill type to concrete, the present insurance rate paid by the owner is less than ⅓ of the amount paid when the old plant was used. In this case, to the other words of the text a third may well be added: "Concrete for economy."

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[1] Data, courtesy *Concrete and Constructional Engineering,* London

[2] Winget, Ltd., London

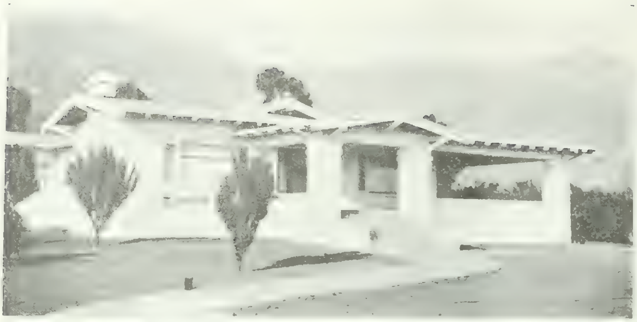

Fig. 1—A Concrete Bungalow in the California Mountains

Builds Hollow Wall Bungalow With Home Made Machine

By Henry L. Wilson

The accompanying illustration shows a nine-room bungalow recently designed and built by the writer for Rev. Seth O. Rees in Pasadena, Cal.

The bungalow is constructed with hollow concrete walls. The forms are my own idea and have proved a success both in durability and low cost. Two 3-in. concrete walls with a 2-in. air space between form the wall section. The walls are bonded by metal studs made from 24-ga. galvanized sheet metal cut in strips 6″ wide x 9′ long. Each edge of studs was turned back with a ½-in. circle which stiffens the studs and forms a clinch in the concrete walls. The foundation walls were put in in the usual way, a solid 10-in. wall to floor joists; the metal studs were then set up edgewise across the wall on 18-in. centers and were held in line by a temporary plate at the top. The hollow walls were then started on the foundation.

FORMS

The forms used consisted of two pieces of ordinary 2 x 10 lumber 6′ long, two iron clamps made of 1 ¾-in. channel iron bent U-shaped to fit over the outside of the form borads and to hold them in place while the concrete was being put in. Near each end of the boards a small steel pin was driven through near the bottom edge projecting about 2″ to catch on top of the wall and to hold the forms up in place. The cores were made of wood 2″ thick, 10″ deep and 18″ long, with two large screw-eyes in the top by which to pull them out. There cores were placed between the metal studs; the 2 x 10's were placed at each side, the clamps placed over them; they were then filled with semi-wet concrete, well tamped, when the cores were pulled, the clamps removed and the boards moved forward their length, set up and refilled, and so on around the house to the starting point. By that time the concrete had set sufficiently to permit another course to be placed and so on until the walls were finished. A set of these forms cost less than $5.

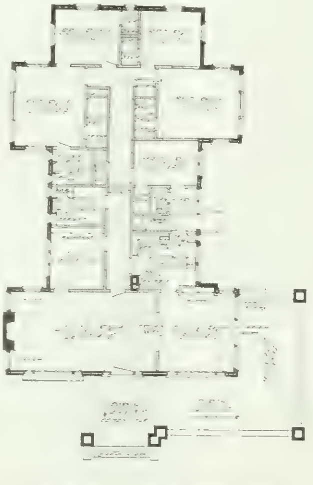

Fig. 2—Floor Plan of Bungalow

GENERAL FEATURES

After the rough concrete walls were up they were finished with Atlas white cement[2] and silica sand; the insides of the walls are plastered directly on the concrete. Inside partitions may be built in the same manner, but in this bungalow 2 x 4 studs were used, lathed and plastered in the usual way.

The bungalow contains nine rooms and basement; living room, dining room and den; it has panel wainscoting and beamed ceilings, oak trim and oak floors. Living room has tile mantel with book cases on either side. There is a large buffet in the dining room; the kitchen is fully equipped with all modern conveniences. A concrete garage large enough to accommodate two cars was also built, and the house and garage were constructed for about $5,000.

Loss of Cement in Flood Not "An Act of God"

In the case of the Crescent Portland Cement Co. vs. The Riverside Fuel & Supply Co., Fremont, Ohio, in which a judgment for $271.52 was secured by the plaintiff, Judge Young decided that the damage to the cement which was spoiled when caught in the 1913 flood was not an act of God. The court held that inasmuch as the river was rising Mar. 23, with warning given, and as the car was not received in Fremont until the next day, care should have been exercised in keeping the car out of the flood district. The defendants pleaded the flood an act of God, as a defense, but as the title passed to the defendants after the cement had been loaded on the car in Pennsylvania, Judge Young held that the Fremont company should pay for the cement after disposing of the question of the alleged act of God.

Out in Bellingham, Wn., the county engr. is laying a great many concrete highways and suggests that all defective places shall be repaired with cement mortar instead of tar, sand or other unsightly material. This he claims to have done with excellent results. The method he uses is to remove carefully all defective portions, as a dentist would from a tooth, wash out the cavity carefully and coat with neat cement; fill with mortar of 1 part cement to 2 of coarse sand; trowel mortar firmly; cover patch with wet sand and keep it moist for several days.

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[1] Archt., Los Angeles, Cal.

[2] Atlas Portland Cement Co., N. Y. C.

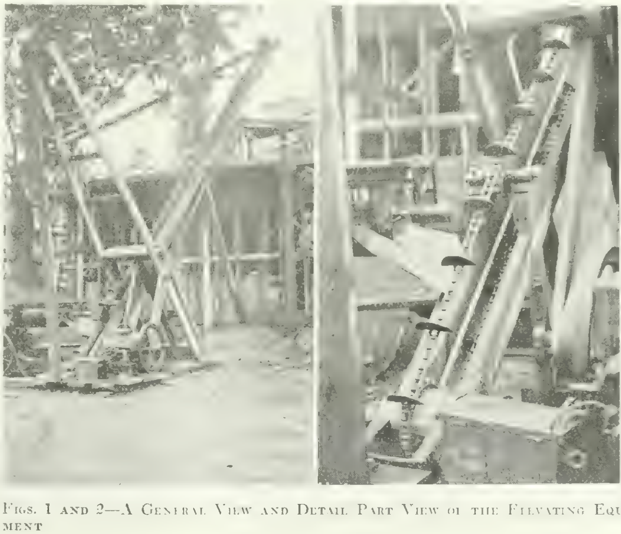
Building Low Cost Houses With Unit Forms and Continuous Conveyor System

Staff Article

Low costs are being obtained by the Humphrey Co., Cleveland, in the construction of small concrete cottages at Euclid Beach Park, using a new commercial system of forms consisting of plates and ribs[1] and for placing the concrete a continuous mixer[2] with elevating equipment designed by D. S. Humphrey. The work has been in charge of P. M. Killaly, engineer for the Humphrey Co. The initial undertaking in this construction of concrete cottages was described in CONCRETE more than a year ago.[3] In the first work a system of wood forms were used which, it was found, required too much time in erecting. Further work has been waiting in the meantime for the perfection of the commercial system of forms which is now in use and which probably will be used in the construction of many other cottages if the work continues as satisfactorily as it is now believed it will.

The two cottages recently built are 35′ x 22′ outside dimensions and 9′ high from floor to ceiling. They are for summer campers and will replace tents which the Humphrey Co. has rented for various short periods of time in the summer at Euclid Beach. Canvas tents were found very expensive, as they lasted in good condition only two or three seasons and the construction of concrete cottages along some rather original lines was undertaken with the idea of finding something which would be more economical in the long run. The cottages have three rooms, including a fairly large living room, kitchen and bath room, with hot and cold water and a porch extending around three sides of the house, which is to be screened off and used probably for the most part for sleeping accommodations. The plan dimensions include the porch. No attempt has been made to build these houses for all year around occupancy and yet as a test of just how satisfactory the cottages are, it is proposed that the caretaker at the park shall spend this winter in one of the houses and find out whether or not he is able to make himself comfortable with the thin wall construction. The walls are 4″ thick, the slabs for the floor and the roof are 5″ thick. The roof is surmounted by a low parapet all around and the roof slab covered over with 6″ or 8″ of soil, on which grass will be grown. The idea of this soil and sod covering is to prevent the rooms below from becoming too hot under the summer sun. The floors are laid directly on the ground, being constructed first, and the forms set up on top of them. The soil is well drained and sandy along the water front and it is believed that for the purposes intended this method of construction will prove entirely satisfactory. Each of these cottages as now built requires 54 cu. yds. of concrete. Lake gravel is used, screened through a $1\frac{1}{8}$-in. screen, with a mixture of cement in the proportion of 1 part cement to about $3\frac{1}{2}$ parts or 4 parts of the gravel. The gravel costs nothing except hauling and this cost for each cottage does not exceed $20. One house requires 77 bbls. of Portland cement, at a total cost of $99. It took 8 men a little over 4 das. to erect the forms but the foreman of the job is confident that when these forms are entirely perfected, as they had not been in the construction of these houses, it will be possible through greater ease in fitting the plates and the ribs to set up the forms in about half the time that it required on the first two cottages. This would bring the cost of setting up the forms to $34.40, the men being paid at the rate of 24 cts. per hr., with the exception of two men, who were paid 25 cts. per hr. No skilled labor was required. The continuous mixer driven by a Novo[4] engine is used and the concrete is mixed very wet. It falls direct from the mixer trough into the elevator which is shown in the accompanying illustration.

As has previously been described, this elevator for the concrete consists merely of paddles on a chain operating in a trough. This chain is run at high speed so that whatever concrete slips through one paddle is picked up by the next one. The rapidity of operation makes it possible to convey even a pail of water from the bottom of the conveyor to the top of the house. The framework supporting this conveyor and the conveyor itself have been enlarged somewhat and strengthened since the photographs were taken, which are reproduced herewith. The elevator is driven by a 3-h. p. Fairbanks-Morse engine.[5] The concrete empties into a spout at the top and this is pivoted so that it can be moved around to cover the entire area, making pouring continuous. With this equipment and with 7



FIGS. 1 AND 2—A GENERAL VIEW AND DETAIL PART VIEW OF THE ELEVATING EQUIPMENT

men on the job a house complete except for the floor which was previously made and for the parapet above the roof, was poured in 3 hrs. The nature of the conveying apparatus serves as a continuation of the mixing process so that when the concrete leaves the end of the conveyor it is in excellent condition and, so far as can be noted, without any separation of the fine from the coarse material. The resulting concrete surfaces are good and without pockets and almost free from pinholes .

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[1] Hydraulic Pressed Steel Co., Cleveland
[2] Elite Mfg. Co., Ashland, Ohio
[3] Nov., 1914, issue, p. 222
[4] Novo Engine Co., Lansing, Mich.
[5] Fairbanks, Morse & Co., Chicago

With the new system of forms it is possible in fairly good weather to remove the plates 24 hrs. after pouring. The ribs which hold the plates remain in place as long as may be necessary to support the walls. The forms can be stripped by eight men in one day and in that time given all the cleaning that is required. The surfaces are very smooth and with reasonable care the forms are expected to last a long time with but small depreciation.

In the construction of the cottages an unusually large amount of steel was required in order to conform to the building ordinance of Cleveland and for this job amounted to 5,032 lbs. at a cost of $105, cut to size. The floor slab has 5/8-in. and 3/8-in. round rods 12″ o. c., the walls 1/2-in. rods 15″ o. c., the roof 5/8-in. and 1/2-in. rods 12″ and 15″ o. c. Trussed rods were used over all wall openings, 5/8-in. rods in all pilasters and columns and 3/4-in. rods were placed in fan shape in the L of the porch. The earlier cottages built more than a year ago with far less steel have been entirely satisfactory.

Mr. Killaly felt that the building department of Cleveland was a little dubious as to the strength of the concrete owing to the method of mixing and depositing, so he took the concrete just as it came from the end of the conveyor and made three 6-in. cubes which showed an average strength at 28 das. of 1,779 lbs. per sq. in.

One of the cottages was given a crandalled finish. This work was done 7 wks. after the house was poured and one man's time was required for 5 das. to do it. Pilasters and corner columns and strips around windows and doors were left smooth for trim. One cottage had approximately 1,057 sq. ft. of surface to be finished and the total cost was $10.75, or approximately 1 ct. per sq. ft. This cost, Mr. Killaly says, can be greatly reduced by doing the finishing soon after forms are removed. Mr. Killaly says that a price of $6 should cover this work if it is done at the right time.

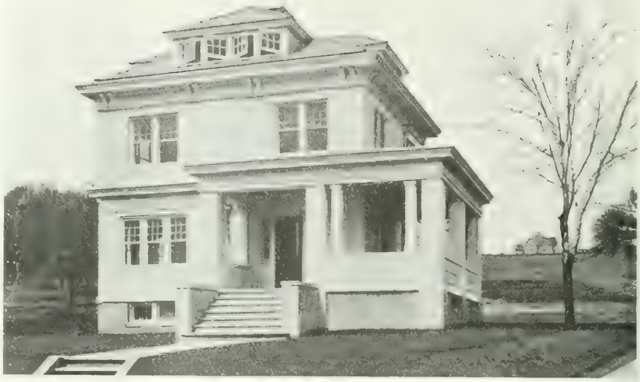
Fig. 1 An Attractive Concrete House at Hackensack, N. Y.

Concrete House Constructed by New Form System

Concrete houses have been constructed satisfactorily without the use of an air space, but it is generally conceded that in the northern part of this country air spacing is essential to good results. To secure such an air space in monolithic construction has been the aim of many concrete workers.

The house described was built by a system which is the invention of Hermann J. Schubert.[1] As will be seen by a study of the illustrations, the forms consist of metal-lined wood sections secured to U-shaped unit frames, which are in turn supported by a scaffold and which grip the wall to preserve alignment. A study of Figs. 2 and 4 will make clear the method by which the outer forms are held and also the provision for adjustments to different wall thicknesses. The forms are seen in use in Fig. 2. The inside form or core is a feature of this construction, as will be noted by a study of Fig. 5. They form thin curtain walls stiffened with vertical ribs which are produced by the shape of the core. The cores are reversed every 2′ in height, resulting in a staggered air space with vertical reinforcing in the ribs as shown at Fig. 6.

GENERAL FEATURES

A special effort was made by the architect[2] to secure pleasing lines and attractive finish. As will be seen in Fig. 3, the house contains seven rooms and a bath and is provided with large, attractive porches. All exterior walls are concrete 12″ thick in the basement and 10″ thick in the superstructure. Concrete partitions are 10″ thick in the basement and 8″ thick in the superstructure. All openings are spanned by reinforced concrete lintels. Porch columns were cast separately and set in place, the other members being molded in place around them. The roof is of frame construction, covered with dark red asbestos shingles. The main cornice is of reinforced concrete, including the brackets, and was cast in place in galvanized sheet iron forms.

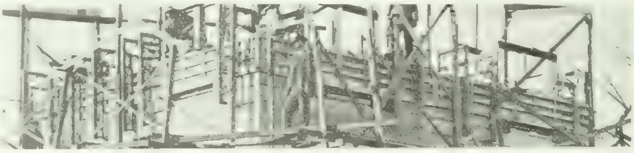
Fig. 2 Wall Construction, Showing Forms in Place

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[1] Hackensack, N. J.

[2] Frederick J. Ritter, Architect, Philadelphia

CONCRETE

The concrete used was mixed 1:2:4, sand and crushed rock being the aggregate used, with the exception that the outer 2″ of the wall were faced with a mixture of white cement[3] and marble dust mixed 1:2. While this facing material and the care necessary in placing it increased the expense, they have produced an exceedingly attractive building.

To avoid showing construction joints the building is divided into courses, as shown in Fig. 1, by means of beveled wood strips attached to the inside of the forms. The result suggests rather than imitates cut stone, as no vertical joint is shown, and serves to break up the surface. After removing the forms the walls were rubbed and then given a brush coat of cement and fine sand and again rubbed. This treatment fills fine imperfections and produces an attractive surface that will not peel, as is likely to occur when a plain cement wash is used.

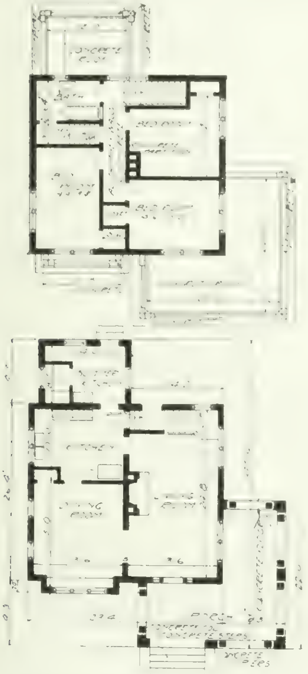
Fig. 3 Floor Plans

REINFORCING

The outer walls are reinforced vertically with 3/8-in. round rods in the center of each rib and horizontally with 5/16-in. rods 24″ o. c. staggered, that is, alternate rods were placed on opposite faces of the wall. All reinforcement is 1″ from the surface. Concrete partitions are reinforced by 5/16″ round rods spaced 18″ o. c. both horizontally and vertically. The kitchen and porch slabs are 5″ thick, reinforced with 3/8-in. round rods 6″ apart and 1/4-in. round rods 2′ apart at right angles. The chimney is of reinforced concrete and contains flues for the furnace, kitchen range and reinforced concrete fireplace. Plastering is directly on the concrete wall, as the air space gives perfect insulation and makes lathing unnecessary.

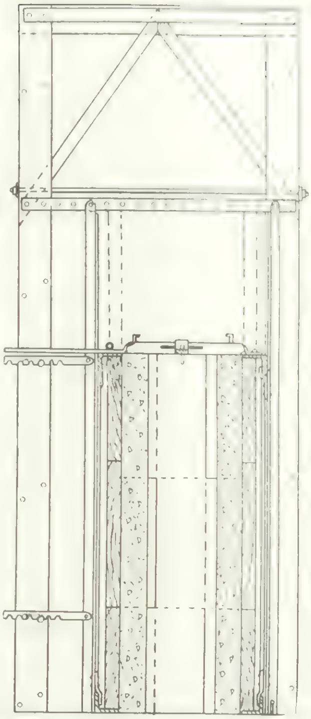
Fig. 4—Section of Wall and Forms, Showing Method of Adjustment

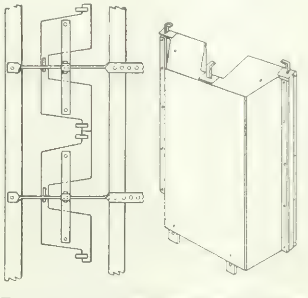
Fig. 5—Detail of Cores and Diagram of Their Arrangement in the Wall

COST DATA

It is evident that in the construction of the first house with a new system, the expense would be considerably beyond what would be expected upon perfection of the equipment and with more experience. This discrepancy was particularly marked in connection with the facing used, as it was found that using white sand and gravel instead of marble dust would materially reduce the cost without sacrificing appearance. The house, including land, was sold for $7,000, and the point is made that it found a ready sale at a time when other houses in the vicinity were not selling. The cost for the concrete work is given as follows:

White concrete, 1,152 cu. ft. @ 46½ cts.	$ 534.24
Mixture	
1 cement ....$3.60 per bbl.	
2 marble dust .... 9.00 per ton	
3 lime stone .... 2.75 per ton	
Plain concrete, 4,463 cu. ft. @ about 15½ cts.	694.79
Mixture	
1 cement ....$1.24 per bbl.	
2½ sand .... 1.50 per yd.	
4 stone .... 1.70 per ton	
Wages for concrete work, including rubbing down	1,221.17
	$2,450.20

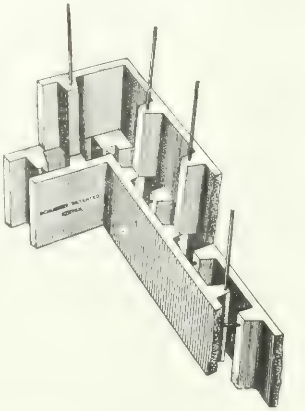
Fig. 6—Section of Wall, Showing Rib Arrangement

According to *Popular Mechanics* a Kansas farmer has been making an American flag out of concrete, thus decorating the front yard with the national colors. "The banner was built up, stripe by stripe, while the blue field was painted on instead of being made of colored material, as were the red stripes. In dimensions it is 4′ x 6′ and is mounted, in flag fashion, 20′ from the ground on a 'tree' also made of concrete.

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[3] Atlas Portland Cement Co., N. Y. C.

Information and *Consultation*: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Composition Flooring in the Concrete Field

THE FOLLOWING QUESTIONS ARE DISCUSSED BY

THE EDITORS

1. Of what is composition flooring made?

2. What possibilities has the laying of these floors for the concrete contractor?

3. What special precautions and methods are essential to its successful use on a concrete base? Do you consider that the material can be successfully laid by a careful mechanic who, without special personal training, will follow directions furnished by supply houses?

4. Do composition floors give satisfactory service? Under what conditions?

EDITORIAL DISCUSSION

A large number of letters asking these questions were sent to architects, contractors and scientific institutions, to composition flooring specialists and to those selling raw materials. The replies received are too numerous to attempt to present them in these columns. The information collected in this way has been supplemented by an exhaustive search of such sources as are available in printed form and by personal observation. The following summary is not the last word but it is hoped that its publication will start free discussion of a material offering great possibilities, but often discredited, through lack of care and knowledge and sometimes used by unscrupulous persons to exploit the inexperienced buyer.

A few quotations, typical of the discussions received and indicating the difference of opinion that exists according to the experience of the writers, are given.

J. J. Kessler[1] takes an optimistic view and says in part:

1. This flooring is made of magnesia and magnesium chloride; the magnesia is used as a base for the dry materials and the chloride is used with the mixing water. These two substances undergo a chemical combination forming an oxychloride. Inert substances, such as cork, sawdust, etc., are used as fillers and besides these substances other ingredients are used to take care of expansion and contraction.

2. Composition floor has great possibilities for the contractor, although its use requires expert supervision. This material is becoming popular and is taking the place of tile, wood, brick and asphalt floors. It is akin to concrete in the method of handling.

3. When the material is supplied by a reputable concern if the workman will carefully carry out instructions in laying there is no reason why these materials cannot be successfully laid. Of course, like concrete floors, it requires experience for the best results but in the use of the materials there is nothing which requires expert handling, excepting that expertness which comes from experience.

4. Composition floors can be used practically everywhere except out of doors; they stand vibration very much better than concrete. The material permits a very much greater variety of finish and is a more attractive flooring than Portland cement concrete.

Extracts from a letter by R. F. Havlik[2] represent those who take the opposite view of the material:

1. Composition flooring is a mixture of oxide of magnesia, which is the cement of the composition, coarse marble, marble dust, a small percentage of saw-dust, a small percentage of asbestos and one or two other inert materials. These materials are mixed in a dry form. Then in place of mixing with water a dilute solution of chloride of magnesia, usually at 22° Breaumé, is used. The degrees Beaumé designate the specific gravity of the liquid. The above composition is usually laid over another mixture consisting of coarse saw-dust, oxide of magnesia, asbestos and marble flour mixed with a diluted solution of chloride of magnesia. The purpose of this second mixture is to act as a binder between the wearing surface and the sub-base, and also to lower the cost.

2. Personally I do not consider that composition floors have any advantages for concrete contractors, nor do they have any advantages over any other types of flooring, except their sanitary value. Composition floors are commonly regarded as resilient and elastic, but this is not the case. They are practically as hard under foot as ordinary concrete, and not much more elastic. I would not under any condition consider the use of the magnesite floor where terrazzo or tile could be used.

3. Magnesite floors cannot be laid successfully on a damp concrete base; extra precaution should be taken to dry the concrete thoroughly. I personally do not consider that an ordinary mechanic can lay magnesite floors successfully by following mail order instructions. He might lay a small job successfully, but would make a failure of a large job.

4. I know of a considerable number of composition floors that give satisfactory service. These floors have been laid over both concrete and wood. Some of them are used in bath rooms and others in public waiting rooms. I have, myself, laid a number of both kinds of floors successfully but the danger of getting an unsatisfactory job is so great that I would not advise my friends to go into the business.

HISTORY

The history of this material dates from the basic patents of Staneslas Sorel of Paris in 1866 but "Sorel Stone," as the new material was termed, was destined to disappoint those who looked for early success. Numerous patents, many of which are expired have been granted, copies of which can be obtained at the patent office. Chemists here and abroad have overcome difficulties and gradually perfected a valuable material.

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[1] Pres., The Dielectric Co., St. Louis, Mo.

[2] Constn. Supt., Mooseheart, Ill.

RAW MATERIALS

Magnesite is mined in Greece and Austria, though some is being produced in this country[3]. It is used largely as a fire-resistive material in the smelting industry and in the manufacture of refractory brick. The raw magnesite is burned to drive off most of the CO_2 which it contains and is shipped in powdered or granular form. Calcium chloride is a by-product chiefly produced by German salt works; it is shipped in crystal or in liquid form and reduced to the proper strength by the addition of water as measured by a hydrometer.

One of the chief difficulties which confronts the composition floor workers is in obtaining materials of standard strength and purity. It is claimed by some floor specialists that the raw materials available to the small buyer are largely the rejections of their chemists.

SECRET FORMULAS

For some years formulas have been offered for sale in connection with representations as to the possibilities for profit in laying composition floors and the manufacture of artificial marble. Careful investigation has shown that the value of such formulas over those available through large public libraries and otherwise accessible by the careful investigator is open to question and that they should be purchased only after investigation of more than usual thoroughness. Representations as to the ease which the business may be learned as told by those selling formulas are generally misleading.

TYPICAL PRACTICE

Among the information on file at this office is a letter describing the materials used by the Aberthaw Construction Co.[4] and describing the practice of that company. We quote from it the following:

> The following formula has been used with very good success:
>
> 10 lbs. Calcined Powdered Magnesite.
> 5 qts. to 7 qts. fine sand (preferably "Plum Island").
> 2 qts. to 3 lbs. White Talc.
> 6 qts. to 7 qts. "Combined Liquid."
>
> The so-called "combined liquid" mentioned in this formula consists of magnesium chloride dissolved in clear water to a consistency of 22° to 24° Beaumé in summer, and from 24° to 26° Beaumé in winter, and magnesium sulphate solution of 15%. To the [illegible] ride a 10% of magnesium sulphate solution is added to prod[illegible] liquid." This liquid is boiled and skimmed before using. The dry materials are mixed thoroughly and the "combined liquid" solution added and slowly and carefully mixed so that the fibre and other materials will not become separated.
>
> If a colored floor is desired, approximately 10% coloring mineral is added for red, brown or buff, and from 1% to 1% black for gr[illegible]. The colors are thoroughly mixed with the dry materials before adding the "combined liquid."
>
> In laying a composition floor, so-called, on a concrete base the base should first be painted with a mixture of the combined liquid and magnesite after ascertaining that the base is thoroughly dry and clean. Over this the mixture is spread, making a floor from 3/8" to 1/2" thick. This gives a splendid wearing surface.
>
> The mixture, in a pasty condition, is gradually worked out upon the floor to a proper thickness for using a straightedge. The amount specified in the formula will cover 10 sq. ft. of floor space 3/8" thick. When the mixture has been properly spread and leveled, it is treated like a regular cement finish or top dressing that is, when sufficiently set, it is worked with a trowel to a smooth surface.
>
> In laying border floors, white pine strips are used to lay out the border. Inside this form the center panel is cast in any desired color. When this center panel has set sufficiently the pine strips are removed and the border cast in another color.

This letter presents in concise form the general methods of laying composition flooring but the point cannot be too strongly emphasized that the raw materials obtainable may vary and that extreme care must be used at every step. Even more than in the handling of Portland cement concrete the careless worker faces certain failure.

READY MIXED MATERIALS

During the last few years a number of firms have offered for sale ready for use flooring material, under various trade names. The prepared floorings seem to depend largely on the skill of the workman for successful use and we advise that they be tried out cautiously to demonstrate the success in the hands of the user before attempting work of any size. A large number of letters have been received from users which indicate that the man who follows directions intelligently and with great care can lay a satisfactory floor.

The editors believe in the light of information now available that composition floor is a material as yet unstandardized except perhaps by a few specialists who do not disclose the results of these researches.

COMPOSITION FLOOR SPECIALISTS

A number of companies have for some years specialized in laying this composition floor. To these people is due great credit for research and experimental work which has demonstrated beyond question, that, in proper hands, a magnesite floor can be laid that is fireproof, sanitary, attractive and lasting. The services of these specialists are now available in the larger cities and their work is laid under a guarantee to give satisfaction.

SUMMARY

The conclusions drawn from the material thus far available are:

1. Composition flooring properly laid gives satisfaction and is often a valuable finish for concrete.

2. Do not buy formulas,—if they possessed exceptional value over those otherwise obtainable they would not be offered for sale. Sources of information, Public Libraries in large cities, Patent Office. CONCRETE will furnish on application. -

(a) List of reliable flooring companies who lay guaranteed floors.

(b) Lists of those who sell raw material.

(c) List of those who sell mixed materials which we believe will give good results.

(d) Such formulas as have been secured. These are probably equal to many offered for sale. They will supply a basis for individual experiment if nothing more.

3. As a side line, we believe the material possesses *possibilities* for the concrete contractor, which he should seek to develop only with great caution and with most careful workmanship.

4. We believe that in general the floorings offered for sale in prepared form can be handled and laid successfully for flooring small areas as halls and bathrooms and that in the hands of the expert would be successful on larger areas. Their use on large areas is not advised until the individual user has demonstrated that he can lay them with success. We consider that by starting in a small way the contractor can gain experience and can gradually build a market for a promising material.

5. We advise that specialists be employed on important work until the user has proven his ability to use the material successfully.

Co-operation by all interested in the development of the material in an effort to learn the truth is desired.

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[3] See the Bull. Production of Magnesite, U. S. Geological Survey, Washington, D. C.

[4] Boston

Furring Walls and Plastering Direct in Concrete House Construction

THE FOLLOWING QUESTION IS DISCUSSED BY:

THE EDITORS

"In residence construction should plaster be applied direct to interior surfaces of walls?"

EDITORIAL DISCUSSION

This magazine has always advised its readers not to plaster direct on the inside of any residence wall which does not provide a continuous air space. This advice has been given repeatedly in spite of apparently successful house construction where plastering has been applied direct to the interior surface. Good results *have been* obtained not only on hollow concrete block where the hollow space is not continuous but also in solid concrete walled houses. This magazine has adhered to the idea that dry walls can not be made a certainty without a continuous air space such as is provided either by a two-piece block or by a double wall of monolithic construction or by furring. There has always been a feeling of hesitancy in pointing out that very successful work has been done where plastering has been applied direct to walls without the continuous hollow space, because it seemed that success could not be *assured* although it is *possible* with the more economical type of construction.

DAMP WALLS

In the early days of concrete house construction, particularly in the use of concrete block, altogether to much reliance was placed upon the fact that most block had a hollow space equal to 25% to 50% of the horizontal area of the block. It was believed by many builders that this partial hollow area in the wall would take care of insulation and to some extent take care of penetrating moisture and make it possible to plaster direct on the interior surface. The result was many failures and this magazine is still receiving letters every little while from owners of or residents in concrete block houses which have damp interior wall surfaces. These failures, however, proceed from two causes and the two causes are absolutely distinct and different. One is the penetration of outside moisture, the other is the condensation of inside moisture. One failure is caused by block which are very poorly made of materials not properly graded so that moisture is admitted *through* the solid webs. Then again, a perfectly good block may be poorly laid up so that water gets in through the joints and this appears on the interior plaster when the plaster has been applied without furring. Further difficulties are sometimes encountered even when block are well made and when well laid up, providing there are settlement cracks or cracks developing through other faults in construction, through which moisture is admitted. The other trouble is encountered even with the best of walls when ventilation is poor or when there is no air space. All of these conditions, commonly encountered in work not properly done from start to finish, have contributed to the position of this magazine in maintaining that the surest way is to fur out on the inside of the ordinary block wall before applying plaster.

CONDENSATION

The admission of moisture from the outside of the wall to the inside of the wall, either through porous block or through cracks, is an entirely different matter, however, from the condensation of moisture on the inside of a wall which may be perfect in every respect. The solid webs of the block communicate temperature changes from the outside of the wall to the inside of the wall so that if there is a great amount of moisture on the inside of the house, as there frequently is in the winter time when ventilation is not so well taken care of, there is condensation of the moisture from the warm air inside on the cold surfaces of the block.

SUCCESSFUL WORK, PLASTERING DIRECT

While it is not the intention of this magazine to recall the advice which it has given it does seem important to call attention to certain developments in the use of concrete block whereby very satisfactory results have been obtained with plastering applied directly to the interior wall surface. This has been accomplished successfully where precautions were taken that no moisture could get through from the outside to the inside. This is commonly done by covering the outer surface with a thoroughly waterproof stucco which seals up all the pores and the cracks and prevents any moisture penetration. As to interior condensation, it is undoubtedly true that if ventilation is well taken care of in the house so that there is a change of air on the inside there will be little danger of condensation on the interior surfaces due to any lack of an insulating air space.

EXPERIENCE WITH UNFURRED WALLS

In the Jan., 1915, issue in connection with the description of houses built by the Sage Foundation Homes Co., at Forest Hills Gardens, Long Island, there was mention of a cored slab used for the walls. These slabs did not supply a continuous air space in the wall but did provide flues not unlike the flues which result from the construction of walls with ordinary hollow concrete block. It was said that there had been no trouble from condensation of moisture on the inside of these walls except in the kitchen in the winter time when the air outside was cold and when there was an unusually large amount of moisture inside due to some kitchen work which provided the unusual conditions.

A further instance of successful work along this line appears to be in the houses erected in England, mentioned elsewhere in this issue. These houses are built of concrete block covered with stucco on the outside and with plaster applied directly to the block on the inside. In making these block there was no attempt to obtain a thoroughly dense block to shed water. The absorption was taken care of by providing on the outside a seal coat of plaster and then a rough-cast coat and these two together are depended upon to keep out moisture from the outside. The strongest evidence, however, of successful work along this line with plaster applied direct to the interior surfaces of block walls is supplied by W. D. Cowperthwaite, Auckland, N. Z. There is further mention elsewhere in this issue of some of the houses he has built. Mr. Cowperthwaite makes no point whatever of trying to get a thoroughly dense block. He says that a block which is not of the densest, most impermeable concrete actually gives better results in the construction of houses in which the plaster is to be applied direct on the inside. These houses are stuccoed very carefully on the outside in order to prevent absorption.

W. F. Schwieterman, gen. mgr. of the Cement, Tile & Block Mfg

Co., Osgood, Ohio, writes that while he has built a great many concrete block houses which were furred on the inside before lath and plaster were applied, he built a house for his own occupancy in which he plastered directly on the block. He says that this construction is not only cheapest but the house has given the best of satisfaction. He says that the walls are perfectly dry and that the only condensation to be noticed is in the kitchen when there is much steam in the room in cold weather. He accounts for this very properly by saying that it is because the room is practically air tight when closed up in the winter, something which is not true in ordinary flimsy construction. In other words, the tighter the house against ventilation the more apt there is to be condensation on the inside.

A FAILURE IN PLASTERING DIRECT

On the other hand William N. Ward, Mgr. of the Twentieth Century Concrete Block Co., Audubon, N. J., writes that houses of concrete block which he has built where no furring was used before plaster was applied have not been satisfactory and that the walls are damp. He says that this dampness is due to condensation and not due to absorption from the outside. This report is typical of hundreds of instances of poor economy in plastering direct.

Rolf R. Newman, Riverside, Cal., says that he has built solid wall houses in New England and in spite of a rigorous climate they have been entirely satisfactory with plaster applied direct on the interior surface of the wall.

All of the accumulated testimony bears out the belief that it is a somewhat complicated problem in which some of the conditions respecting each particular case are not always known. It also seems obvious that the tendency to experience trouble from condensation on the inside, when the wall itself is entirely satisfactory from a waterproof standpoint, is more apt to be met with in very cold climates than in moderate climates. Solid wall houses, for instance, in the vicinity of Washington, D. C., have been entirely satisfactory. Yet a type of construction satisfactory in Washington might prove entirely inadequate in a colder region. It would seem that if a builder is determined to plaster direct on the wall, his problem providing he has good materials to make a watertight wall of, becomes one of ventilation in order to prevent condensation. This situation might be much different with thicker solid walls, because increased thickness of wall obviously would overcome to some extent the tendency of the walls to present a cold surface to moisten on the inside.

William Mayo Venable[1] points out very positively that it is not safe in a cold climate to eliminate interior furring on any type of block wall except one having a continuous interior air space. In his opinion it is not advisable to put interior plaster direct on concrete block nor upon a solid wall unless the wall is more than 9″ thick. It is practicable he says to make walls thick enough so that they can be plastered direct on the inside but it is very expensive and the thickness required depends upon the climate as well as upon the composition of the concrete.

"POPCORN" CONCRETE

In this connection it should be mentioned that there have been suggestions of a so-called "popcorn" concrete. Very porous concrete might be made with cinders and very little sand and while this would not be strong it would undoubtedly have a great tendency to overcome condensation and to provide, by its own porosity, the insulation which is ordinarily secured by means of a continuous air space. Houses built with something of this idea in view are those constructed at Nanticoke, Pa., by Milton Dana Morrill, several years ago[2]. It is urged, however, in this connection by Mr. Venable that such concrete does not provide proper protection for the steel used in reinforcing.

Mr. Cowperthwaite contributes the idea that a solid wall should not be plastered inside with a dense Portland cement mortar, on the theory that a certain amount of moisture is objectionable only when it is evident. A more porous plaster is recommended so that slight condensation will be absorbed. Such walls probably should not be painted so that the pores will be closed. Readers will be familiar with the fact that painted kitchens sometimes show a great deal of condensed moisture on the walls while a wall not so painted absorbs the moisture so that it is not evident.

To sum up these various ideas on the subject of providing insulation against temperature changes and waterproofness as well, in concrete walls it seems that the conservative builder, who wants to be sure of a satisfactory job, will either provide in his wall a continuous air space or else he will fur out before applying lath and plaster. Another builder equally conservative perhaps but with experience along other lines and feeling sure of the character of the work which he and his men are doing, may, like our correspondents in England and in New Zealand, find it very satisfactory to plaster direct on the block. When this is done, however, it seems necessary not only that ventilation be taken care of so as to prevent condensation but that the walls be structurally perfect, not only when first built, but for the future so cracks will not develop, which will admit moisture from outside. It is up to the builder to decide whether or not he is sure enough of his methods and of his men, to save the expense of furring and lath before applying plaster, by the most careful methods in every other respect in his work. The builder who is very sure of the character of work he is getting out of the men in his employ can do a great many things which builders cannot do who are not absolutely sure. Most builders will probably decide that if they are taking chances with solid walls, with no air space, they prefer to take the necessary precaution rather than assume responsibility for chances of failure. To sum up:

Dampness on the interior surfaces of concrete walls may be due to:

1. Poor concrete, which is so porous as to permit the moisture to strike through from the outside.
2. Cracks (caused by poor block laying, by settlement of wall or by temperature movement not properly provided for) through which moisture penetrates to the inside.
3. Lack of air space for insulation in the wall or lack of proper ventilation so that moisture in the air inside the house condenses on the walls.

Mining engineers are taking great interest in concrete in all its forms. This is especially the case with richer mines of various types, the shafts and tunnels of which are expected to be of service for years. Many of these are substituting concrete lumber for ordinary lumber for their timber. This is especially the case in the new workings in the Minnesota iron range. There is also gained by the use of concrete lumber a freedom from risk which is of first importance from the point of view of those who work in the mines and from the point of view of the company by damage to property and loss of life among the miners.

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[1] *Concrete*, Feb., 1912: CONCRETE-CEMENT AGE, Mar., 1913, p. 153, Apr., 1913, p. 173

[1] Chf. Engr., Bldg. Dept., Blaw Steel Constn. Co., Pittsburgh

Correspondence: A Department in Which the *Reader* Becomes the *Writer*

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow."

Concrete Surfaces Plastered and Grouted

A LETTER FROM A. M. WOLF[1]

In any locality where the winters are cold, with great range in temperature, the practice of plastering concrete surfaces with cement mortar to remove form marks and smooth up the roughened surfcases left by the forms, has not, as a general rule, proven satisfactory. Variations in temperature, aided and abetted by variations of moisture in the coating, soon play havoc with plastered concrete surfaces. Examples of the poor results to be obtained by plastering and brush coating can be found in almost every locality. Bridges, buildings, walls and abutments so treated may be satisfactory for a time, but in most cases, after about a year, present a very patchy and spotty appearance, due to the flaking off of the mortar.

The only way that cement mortar can be made to stick on a concrete surface is to prepare the surface especially for such treatment by casting it with a corrugated surface or by roughening the entire surface after the forms are removed. The cost of this treatment will, in many cases, be much more than some better finishes, and so it does not pay to prepare surfaces for plastering, since even then it cannot be depended upon to result in a first-class job.

The writer has personal knowledge of a small concrete passenger station near Chicago which was plastered to obtain a better surface, and the attempt was a failure. Portions of this structure, which was built in 1910, have been replastered several times but the mortar soon cracks and flakes off. In spots the mortar finish has separated entirely from the concrete backing and can be picked off in large flakes.

In another case a concrete retaining wall was brush coated with a thick cement grout at the time of building (1909) in order to eradicate the form marks. This work is also a failure. Large patches of this coating have fallen off. The surface presented is anything but attractive and is much worse than the original, form-marked surface.

These two jobs are typical of a great many unsatisfactory attempts to improve the appearance of concrete surfaces without preparing the surface to receive the plaster, which would necessarily have greatly increased the cost of the finish and, in fact, made the cost prohibitive.

The causes of these defects are numerous and it is, therefore, difficult to say just what the cause may have been in any particular case. Sometimes one condition may be the cause, while in another an entirely different condition or combination of conditions is responsible for the failure.

In general, the surface of any concrete work which is mixed wet is coated with a thin film of cement which produces a relatively smooth surface, not considering the lips caused by irregularities of the forms, to which it is difficult to make a mortar coating or wash stick.

It is a well known fact that a rich mortar, such as is generally used for this work, shrinks much more while hardening in air and expands more rapidly with higher temperature than the concrete upon which it is plastered.

Prof. Alfred H. White, of the University of Michigan, found by experiment that 1:3 mortars contract from 0.08% to 0.1% which is, roughly 1½ times the contraction of 1:2:4 concrete hardening in air as determined by tests in the Office of Public Roads, Dept. of Agriculture. This difference in contraction of cement plaster and concrete explains the cracking and chipping off of plastered concrete surfaces. If the mortar does stick for a time it gradually loses its grip, due to the shrinkage of the mortar while hardening, coupled with the effect of temperature changes due to the difference of the coefficients of linear expansion of the mortar and concrete.

After the cement plaster has become cracked and separated slightly from the concrete, water easily finds its way behind it and if present when freezing weather comes, the plaster will be forced off by the expansive force of the freezing water. Even when a mortar facing placed at the same time as the concrete is used, cases arise in which difference in contraction between the facing and the backward causes cracking and spalling of the surface. The same is true of concrete surfaces coated with a cement wash applied with a brush.

Even when care is exercised by preparing the concrete surface for cement plaster by removing the surface film of cement and roughening it to provide a bond for the plaster, the results are, in the majority of cases, unsatisfactory. Various preparations are advertised and sold which are said to give a positive bond between a concrete surface and a cement plaster coat. These, however, have not been used with any marked degree of success in work exposed to the air.

Cement plaster applied to surfaces which are always damp or under water gives satisfaction in nearly all cases. This is due to the fact that the expansion of the finish and the concrete while hardening under water or in the presence of moisture is relatively small as compared with the shrinkage when cured in air and more nearly the same for both.

If a concrete surface, as left by the forms, is to be finished in some manner for the sake of appearance, plastering or brush coating is simply "jumping from the frying pan into the fire." Plastered concrete surfaces have been tried and found wanting too often to warrant their specification for any job.

Several other methods of surface finish, which are much better, more durable and vastly more satisfactory, can be employed. The cheapest of these finishes is the one obtained by rubbing the surface of concrete with carborundum or cement brick before the concrete has thoroughly hardened. The cost of finishing concrete surfaces in this manner ranges from 1½ cts. to 3 cts. per sq. ft., depending on the nature of the work, i. e., whether plain or broken up by reveals, panels and moldings. The surface produced by rubbing is of lighter color than the ordinary concrete surface, is more nearly impervious, does away with form marks, and in fact, is the ideal method of low-cost finish for concrete work.

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[1] The Condron Co., Chicago

If the main object is to color the surface of the existing wall the writer suggests the use of one of the standard brands of cement paint applied in one or more coats after the surface has been treated (if a smooth surface is desired) as follows:

After the forms have been removed and the concrete has seasoned and dried out for a few days, the lips and ridges in the concrete, due to irregularities in the forms, must be chipped off with chisel, coarse file or rasp. The surface should then be wet and rubbed with a coarse carborundum brick until it is fairly smooth. After this apply a thin wash of cement and sand and allow it to dry. The final rubbing should then be done with a fine carborundum stone until all the cement wash has disappeared and the surface is of the desired smoothness.

Organizations

American Concrete Institute, John M. Goodell, Acting Secretary, 1118 Walnut St., Philadelphia, Pa. Convention, Chicago, Feb. 14-17.

American Concrete Pipe Association, Secretary, E. S. Hanson, 538 S. Clark St., Chicago. Convention, Chicago, Feb. 17-18.

American Highway Association, Chas. P. Light, Field Secretary; Colorado Bldg., Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C. Convention, Pittsburgh, Feb. 28-Mar. 3.

Association of American Portland Cement Manufacturers, J. P. Beck, Gen. M'gr., Bellevue Court Building, Philadelphia, Pa.

Cement Products Exhibition Co., 208 S. LaSalle St., Chicago, Ill.; Robt. F. Hall, Secy., Chicago Cement Show, Coliseum and First Infantry Armory, Feb. 12-19, 1916.

Mid West Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb. Convention, Omaha, Mar. 1-4, and Mid-West Cement Show, Feb. 29-Mar. 4, 1916.

Second National Conference on Concrete Road Building, J. P. Beck, Sec'y, 208 So. LaSalle St., Chicago. Chicago, Feb. 15-18, 1916.

Convention of the American Concrete Institute

Announcement is made of the annual convention of the Am. Concrete Institute, to be held in Chicago, Feb. 14 to 17, inclusive. This is the same week that the Cement Show, Road Conference and Am. Concrete Pipe Assn. Convention are held. The Institute's directors desire to co-operate as completely as possible with those other societies which are specializing in concrete work and for this reason the program has not been definitely settled.

The sessions of the Institute will be held in the morning and evening, and it is expected that joint sessions with other organizations will be arranged for some of the afternoons. The annual banquet will be held on the evening of Feb. 16.

In addition to important committee reports, the following papers have been definitely promised:

C. W. Simpson, "The Construction of the New Concrete Viaducts on the Lackawanna Railroad;" Earl B. Smith, "Tests of Large Size Concrete Slabs;" P. P. Furber, "Requirements of building Codes for Columns and the Designof Columns;" W. P. Anderson, "The Design of Reinforced Concrete Building;" Frank Raschig, "Concrete Viaducts;" Maynard & Baker, "Concrete on the Massachusetts State Farm;" Ralph A. Sherwin, "Forms for Concrete;" Edward D. Boyer, "Swimming Pools;" Moore & Fuller, "Tests Showing Continued Deformation Under Constant Load;" R. D. Stubbs, "Pavements;" H. S. Van Acoyoc, "The Construction of the Toronto-Hamilton Highway by Day Labor;" Charles Upham, "The Construction of the DuPont Concrete Boulevard;" William M. Acheson, "The Essential Features for the Successful Construction of Concrete Highways;" Clifford Richardson, "Concrete Foundations for Heavy Traffic Street Pavements;" Charles C. Brown, "How Shall a Rational Specification for Gravel Concrete Be Developed?" D. A. Abrams, "Tests of Sands for Concrete;" George A. Rankin, "The Nature of Portland Cement;" J. M. Braune, "Tests of Concrete Materials at Cincinnati;" W. K. Hatt, "The Genesis of Reinforced Concrete Construction;" Burtis S. Brown, "Recent Tests of Reinforced Concrete Columns;" W. W. Horner, "The Design of Plain and Reinforced Concrete Sewers;" Coleman Meriwether, "The Manufacture and Use of Reinforced Concrete Pipe;" J. H. Libberton, "The Durability of Concrete Pipe;" George Sampson, "The Reinforced Concrete Water Tower at Middleboro, Mass.;" Lamar Lyndon, "The Design and Construction of the New Dam and Reservoir at Austin, Tex.;" Wilson Fitch Smith, "Methods of Construction at the Kensico Dam, Catskill Water Supply, New York City;" Frank H. Fay, "Concrete Conduits at Fall River, Mass.;" Ridgway & Goodwin, "Novel Methods of Concrete Construction on the New Subways in New York;" William C. Archer, "The Operation of the New York Workmen's Compensation Law to Date;" H. L. Lewman, "An Interpretation of the New Standard Building Contract Documents."

In addition to those papers definitely promised, others have been conditionally promised.

Some Features of the Cement Show

A tentative outline of the probable features of the exhibit of the 27 Portland cement companies which are making a joint effort to produce something of considerable educational value at the next Chicago Cement show is as follows:

One booth is to show achievements in structural concrete by means probably of transparencies with emphasis on the fire at the Edison plant and the fire at Salem. This same booth will probably contain small walls of concrete or good sized specimens on tables which will show results obtained by rubbing with carborundum block, brushing or scrubbing while green, acid washing and bush-hammering, with costs of the various surface finishes. In this connection it is proposed to show photographs of some notable work on which each particular surface treatment was used. By means of an automatically operated stereopticon it is proposed to show pictures of good and of bad building practice. Another exhibit in connection with this booth probably will be a section of balustrade such as is now being built by the South Park Commission in Chicago. It is also proposed to show sills, lintels and decorative cast stone made by some of the foremost manufacturers.

In another booth it is proposed to show concrete road building developments, this exhibit to include road models with light projectors to throw pictures on a screen; full-sized sections of concrete streets and roads and alleys, with special emphasis on some of the construction features; a chart showing maintenance methods used on concrete roads in Illinois and in Milwaukee county.

Still another will be devoted to the general subject of good concrete and probably will show a sand and gravel washing and grading machine, made quarter-size, which will be operated so as to show the benefit of using proper aggreates in preference to pit-run gravel and dirty materials. There will be samples of clean materials and dirty materials on hand, with records of tests and specimens made from the dirty and from the clean material. There will be a graphic demonstration of the difference getween 1:2:4 concrete and 1:2:6 concrete. It is also proposed to show a testing machine and every hour or so to break several good and several bad specimens. In this same booth methods will be shown for laying and curing concrete floors to overcome dusting.

A booth will be devoted to good examples of unit construction with concrete block from several manufacturers who are turning out a high grade of faced products. In general it is proposed to illustrate all of the principal systems of block construction and in addition there will be a series of home-made wooden block molds used merely to demonstrate methods of applying facing materials and of treating surfaces to expose aggregates.

There will be a strong appeal to the rural contractor, featuring septic tanks, drain tiles, sewer pipes, fence posts and silos. There will be photographs, transparencies and small models.

In a general reception booth it is proposed to feature a map with electric lights to designate the plants of various cement manufacturing companies. In all of the booths and in connection with the decorations there will be concrete garden furniture, vases, bird baths, sun dials, etc., obtained from successful manufacturers. There will probably be a motion picture booth which will show a number of films.

These, at least, are part of the features which it is proposed to have in connection with the joint exhibit. Not all are definitely promised but if some of them are omitted others of equal value will probably be substituted.

Am. Concrete Pipe Assn.

Announcement is made by E. S. Hanson, Secy. of the Am. Concrete Pipe Assn., that the development of the program for the convention of the Association to be held in Chicago Feb. 17 and 18, 1916, promises interesting and instructive features. Among those on the program are A. O. Eberhart, ex-gov. of Minnesota; Edmund T. Perkins, formerly with the Reclamation Service and now head of the Edmund T. Perkins Engrg. Co., Chicago, specialists in irrigation and drainage work; C. M. Wood, who will discuss the question, "Should Manufacturers Contract for Laying Their Own Pipe?" and G. E. Warren, who will discuss, "Advantages of Big Tile Over the Open Ditch." A new constitution and bylaws by the reorganization committee will come up for discussion and vote.

Assn. of Am. Portland Cement Mfrs. Elects Officers

At the annual meeting of the Assn. of Am. Portland Cement Mfrs., held in N. Y. C. on Dec. 15, 1915, the following officers were elected:

Pres., B. F. Affleck; 1st vice-pres., F. W. Kelley; 2nd vice-pres., Richard Hardy; gen. mgr., J. P. Beck; asst. secy., L. R. Ferguson; treas., G. S. Brown; asst. treas., John J. Matthes.

Percy H. Wilson, who has served as secy. for a number of years, resigned and J. P. Beck was elected gen. mgr. of the Association. The Association unanimously approved of a comprehensive plan for enlarging the activities of the organization submitted by Mr. Beck, and by resolution the Executive Committee was instructed to carry into operation the proposals in the report.

Mr. Affleck, the new president. is pres. of the Universal Portland Cement Co.; Mr. Kelley is pres. of the Helderberg Cement Co. and Mr. Hardy and Mr. Brown are, respectively, presidents of the Dixie Portland Cement Co. and Alpha Portland Cement Co. Mr. Ferguson has been connected with the Association for some time as asst. secy. Mr. Matthes is treas. of the Alpha Portland Cement Co.

Am. Road Builders 'Assn.

Announcement is made that the 13th annual convention of the Am. Road Builders' Assn. will be held in Pittsburgh the week of Feb. 28, closing Mar. 3 instead of the week of Feb. 22, as previously announced. One of the reasons for making the change is the necessity for alterations in Mechanical Hall, where the exhibit and convention will be held.

The Building Data League

A new technical society known as the Building Data League, has been recently incorporated in New York. The purposes of this league are entirely different from those of most technical societies, the object being to provide systematic ratings for building and construction materials.

The work being done by this association is somewhat along the lines of the Underwriters' Laboratory and the Bur. of Standards, but will be limited to building materials and appurtenances. Both new and somewhat standardized materials will be subjected to impartial tests by the Building Data Co., a corporation connected with the League, the expense of tests to be borne by the manufacturer. A report will be rendered impartially upon the findings of the investigating board. These findings will be published in bulletin and in circular form and supplied to each member. The membership of the League is already considerable, and is recruited mainly from architects and engineers. The organization has offices at 105 West 40th St., N. Y. C., where further information can be obtained.

To Test Hydrated Lime in Concrete

The U. S. Bur. of Standards is to undertake tests to determine the value of hydrated lime in concrete mixtures for various purposs. The work will be in charge of a committee selected by P. H. Bates and W. E. Emley of the Bureau. The advisory committee, representing the cement and the lime industrys, the engineers, and the contractors, is made up of Nathan C. Johnson, N. Y. C.; Alfred H. White, University of Michigan; S. C. Potts, Pennsylvania Railroad System, Altoona, Pa.; Dr. J. N. Mackall, of the Maryland State Highway Commission, Baltimore, Md.; W. A. McIntyre of the Assn. of Am. Portland Cement Mfrs.; Ernest Ashton, of the Lehigh Portland Cement Co.; E. D. Boyer, of the Atlas Portland Cement Co.; W. M. Kinney, Universal Portland Cement Co.; W. E. Carson, Pres. Lime Mfrs. Assn.; Lawrence Hitchcock, chairman of the Executive Committee of the Hydrated Lime Bureau, and N. C. Hough, manager of the Hydrated Lime Bureau; the James L. Stewart Construction Co., Pittsburgh; W. L. Prettyman, Pres. of the Concrete Construction Co., Philadelphia, and H. L. Smith, general Manager of the Turner Construction Co., N. Y. C. The tests as outlined include determination of compressive strength, expansion, reinforcement, permeability, action of sea water, the hydration of cement, absorption, segregation, abrasion and adhesion of cement to reinforcement. Specimens to which varying proportions of hydrated lime have been added, up to 5 yrs. of age, will be tested.

Am. Road Builders' Assn. Suggests Joint Convention

At a special meeting of the Am. Road Builders' Assn., Dec. 16, 1915, resolutions were adopted inviting the Am. Highway Assn. to hold its annual convention at Pittsburgh, beginning Feb. 28, 1916. These are the place and date selected by the Am. Road Builders' Assn. for its annual convention.

This arrangement would be of great advantage, not only to highway officials, but also to those who wish to conduct exhibits in connection with these conventions.

The suggestion is offered that the two organizations co-operate to secure papers which shall avoid duplication of subjects and in other ways to produce a program of maximum value to members of both Associations.

It is hoped that this plan will be accepted by the Am. Highway Assn. and be found satisfactory, not only for 1916, but for subsequent meetings which, it is suggested, may be held under alternate control.

New Equipment, Methods and Materials:

New Tools with Which the Industry Works ☐ ☐

***This** magazine will not publish "reading notices," so-called, for the benefit of advertisers. **These** pages are edited for the Reader, as are all other pages in "Concrete." Manufacturers **are** constantly producing new and better methods and developing old methods, materials and machines. The progress of the concrete field is measured by the development of its tools. All developments along these lines are of real interest and importance to men who want to improve the quality of their work, decrease its cost, increase its quantity. This department is for just that kind of Editorial material. We, therefore, welcome detailed announcements which will be of practical value to Readers. Under no circumstances will this magazine publish any announcement simply because an advertiser asks it, nor refuse publication because a non-advertiser asks it. Material must carry information of real consequence to the reader. All material will be edited on that basis regardless of the source from which it comes.*—The Editors.

A Level That "Talks"

New Level Shows Grades

An indicating level[1] that should be of especial value to concrete workers is illustrated.

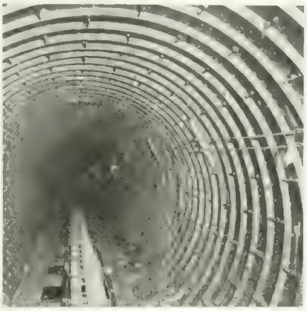
It will be noted that the vial and bubble have been replaced by a hollow glass disk partially filled with red liquid.

The glass is protected by a graduated brass plate which shows directly and accurately the amount a piece of work is out of level.

For sidewalk and other graded work, as well as for general purposes, this feature is valuable. The level is made in a range of sizes to suit all needs.

Steel Plates for Tunnel Lining

Steel plates[2] of special design have recently come into use to take the place of timbering in tunnels. The plates are stamped to form a segment of the required circle and provided with a flange which acts as a stiffener and also provides means of bolting the units together.



Tunnel Lined with Steel Plates

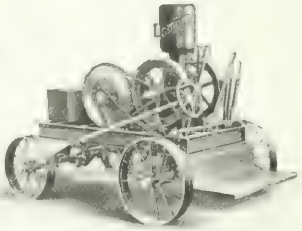
The illustration conveys a good idea of their appearance in use. The tunnel forms are placed inside of this steel shell and the intervening space filled with concrete.

The Oshkosh Backfiller

The Oshkosh Backfiller,[1] while designed for backfilling, can be used for any purpose where a team with plow and scraper would be used to move dirt.

It can also be used for hauling timber and steel on the job for boosting wagons and in connection with a derrick or emergency rig for hoisting purposes.

The equipment consists of a powerful winch on a 3-point mounting which enables it to work readily over rough ground.



The Oshkosh Backfiller

The truck and winch are driven by a 6-h. p. Novo[2] engine, so that the machine is placed or moved under its own power. The engine and the winch are mounted so as to allow a pull at any angle without crowding the cable or piling it up on the drum. The cable speed is 125′ per min.

A Simple Apparatus Raises Side of Concrete House

Readers of Concrete have noted from time to time descriptions of buildings which have been erected in large pre-cast sections. One of the latest developments in this direction has been worked out by Rollin C. Ogburn,[1] under the name of the Economy system.

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[1] Toledo Indicating Level Co., Toledo, Ohio
[2] Blaw Steel Const. Co., Pittsburgh

[1] Oshkosh Mfg. Co., Oshkosh, Wis.

[1] Des Moines, Ia.
[2] Novo Engine Co., Lansing, Mich.

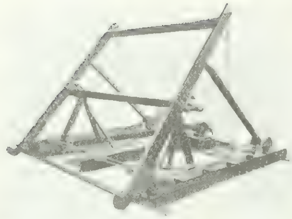


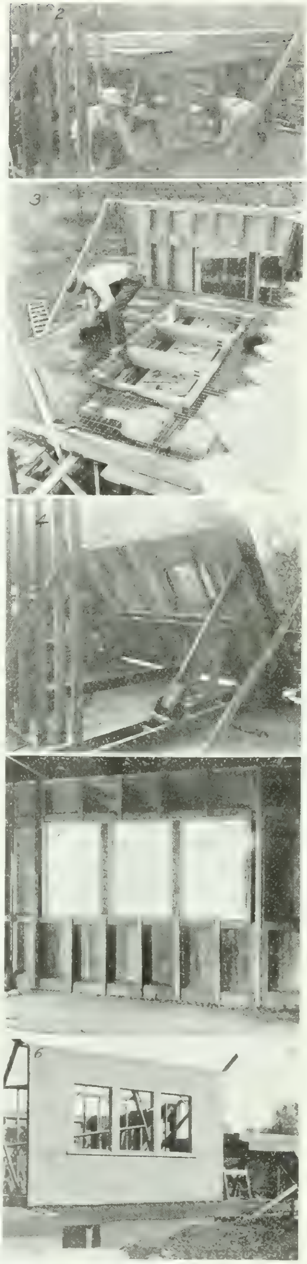
Fig. 1 Erecting Machine

Mr. Ogburn has worked out a number of ingenious and economical methods which give promise of a successful future.

In Fig. 1, is shown a machine which is the key to the whole system, as it readily enables two or three men to lift and place these large concrete units, which are a story in height and from 10′ to 20′ in length. A study of this and the succeeding views will show that the concrete slabs are cast on a temporary platform raised on trestles. On this platform are placed the window and the door frames and also cores which greatly lighten and serve to air-space the wall. A special core of plaster has been economically worked out, one of which is shown in Fig. 7. With frames and cores in place, the reinforcing is next positioned, consisting of rods in the beam members and wire mesh for the panels. This stage of the operation is well shown in Fig. 3.

The concrete having hardened sufficiently, the machine is slid into place under the forms as in Fig. 2, then by means of tilting arrangements and suitable backstays the slab is swung into the position shown in Fig. 4. Two arms are then brought into play which slide on tracks and by means of a winch the slabs are forced to an upright position. A rather simple cam arrangement at the bottom of the machine provides for final exact placing of the slab. This allows the slab to be worked backward or forward or raised and lowered repeatedly until perfectly bedded in its exact position. The whole operation is under perfect control of the operators. Fig. 5 shows the slabs as seen from the interior of the building, with furring strips in place for nailing lath and the open appearance caused by the cores. In Fig. 6 is seen the exterior view of the same slab.

Fig. 8 Finished House



Figs. 2-6 Progressive Stages in Making and Raising Concrete Slab

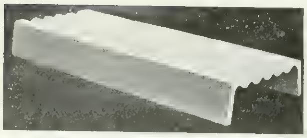


Fig. 7 Plaster Core

The plaster cores used are cast by the contractor on the job or at odd times and are said to be very inexpensive and a great improvement over the wooden forms which were first used with this system. A number of houses have been built by this system, one of which is illustrated. The whole operation has resulted in attractive and very economical buildings.

A Small Gravel Washing Plant

The City of Milwaukee is situated in a glacial district, plentifully supplied with gravel pits. Some limestone is also available. After trying both materials, the Wisconsin Highway Commission has issued specifications as follows:

Coarse Aggregate.—The coarse aggregate shall consist of clean, hard, sound flint, or other hard siliceous pebbles, having a reasonably uniform graduation from a size which will pass through a 1½-in. round screen to a size that is retained on a ¼-in. screen, and no gravel composed in part of slate, shale or disintegrated stone may be used. Crushed granite, quartzite, limestone or trap rock, graded to the size specified above, may be used upon the approval of the Engineer. In no case will coarse aggregate be approved which has a French coefficient of wear of less than 10, and none having any dimension greater than 2″ will be allowed to be used. The right is reserved to reject for cause any or all stone or gravel delivered on the work.

Fine Aggregate.—The fine aggregate shall consist of clean, sharp grains of silica or hard silica rocks, and shall not contain over 3% of clay or loam. The fine aggregate shall have a reasonably uniform graduation from a size which will pass through a ¼-in. screen down. Sand containing an appreciable percentage of flat flakes shall not be used. Fine aggregate other than the above may be used only upon the written approval of the Engineer.

Pit-Run Gravel.—Pit-run gravel shall not be used except when screened to the above two sizes and delivered separately on the road. Aggregate containing lumps of clay or frozen material shall not be used.

As the county is building 43 mi. of one-course concrete road in 1915, there is a considerable demand for material complying with the county specifications. Quite a number of big gravel washing plants have been established at different points in

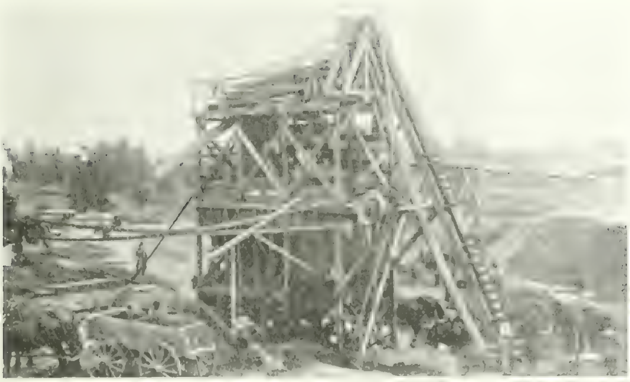


Fig. 1—Driving Side of Gravel Washing Plant; Bins Discharge to Wagons on Opposite Side

Milwaukee and in Waukesha County, in order to meet this demand. A number of small plants have also been started, to supply the demand at isolated points. One of the most interesting of these enterprises is a small plant erected by E. E. Cain, Wauwatosa, Wis. The illustration shows the general construction of Mr. Cain's plant. No crusher was installed, as there were few big boulders in the pit. All over-size stones are wasted.

The bin has a capacity of 30 cu. yds. As it seemed probable that the plant would be moved to another location within a year or so, a special take-down bin was used. All timbers are bolted together, with a view to dismantling and re-erecting the bin at a low figure. Power is supplied by a steam tractor. A steam pump furnishes the water supply, steam being obtained from the tractor. The elevator is of the usual back-geared belt type, with 13-in. buckets. Bucket speed is approximately 172′ per min. The screen is 32″ in diam. by 12′ long. The screening cylinder is made "blind," for the first 3′, to serve as a washer. This section is equipped with angles to lift and pour the material. Two retarding rings are put in the washing section, to prevent the material from passing too rapidly. The balance of the main screening cylinder is punched with 1½-in. holes. Seven feet of the main screen are enclosed by an outer packet of steel wire, 3-mesh, No. 10 wire, this jacket screening out the sand.

The sand and water passing this outer jacket go to the settling tank, which is a wedge-shaped hopper, pivoted on a knife-edge and counterweighted. The center of gravity in this hopper is so arranged that when full of water it will remain upright; but when a considerable amount of sand is accumulated, it will tip, permitting the sand to drain off through a hole in the bottom of the tank.

A plant of this character has a capacity of approximately 20 yds. of clean washed gravel per da. The rules of the Milwaukee County Highway Commission are very strict and it is necessary to wash the material very thoroughly. The plant was designed with this in view and the material produced is passing inspection.

A plant of this character will cost[1] about as follows:

1 No. 3 single chain elevator, 43-ft. centers, with countershaft and driving pulley	$ 340.00
1 steel lining for washing hopper at elevator head	15.00
1 Telsmith heavy duty screen, 32″ diam. x 12′ long, including 3-ft. scrubbing section with baffle plates and 7-ft. steel wire dust jacket	360.00
1 set of chute linings	10.00
1 settling tank	63.00
Sprocket chain, for drive from countershaft to head shaft, and from elevator head shaft to screen, including sprocket and outboard bearing on head shaft	25.00
1 20-h. p. electric motor, or twin-cylinder gas engine, approximate only	400.00
1 belt from power plant to elevator, about 50	24.00
1 centrifugal pump, including pipe, etc., about 200 r. p. m.	115.00
1 extra pulley on countershaft with 40-ft. belt to drive pump, about	25.00
2 chute bin gates, 12″ x 14″	20.00
1 special bin gate, 12″ x 14″, for sand bin	13.00
Hardware for 30-ton take-down bin	100.00
Lumber, about 6,500 ft., B. M., @ about 3½ cts. per ft.	227.50
Concrete, about 14 cu. yds. for foundation piers and elevator pit, @ $9.00 per cu. yd.	126.00
Erecting	300.00
Total	$2,191.50

The above estimate does not include cost of digging a well, it being assumed that city pressure or a natural stream is available within a short distance.

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[1] Estimate by T. L. Smith Co., Milwaukee, on equipment installed for this plant

Company Formed to Establish Plants to Make Eberling Tile

Cleveland capitalists have purchased the interests of the Eberling Cement Machy. Co., on whose equipment the Eberling concrete structural tile are made, and the interests of the Delta Brick & Tile Co., Detroit, which owned a plant in Detroit manufacturing Eberling tile on a commercial basis. A new company has been formed, capitalized at $250,000, under the style of the Eberling Machy. Co., for developing the equipment manufactured by the company and establishing local plants at different points for the manufacture of the tile. S. H. Wightman is gen. mgr. of the new company.

Concrete House Should Win This

An architectural competition of the most practical kind will be held in connection with the first American Complete Building Show, in Cleveland, Feb. 16 to 26, under the direction of the Cleveland Chapter, A. I. A., in co-operation with the Chamber of Commerce, Cleveland Art Assn., Builders' Exchange, Society Advocating Fire Elimination, and other civic bodies.

The competition is for a workingman's home to cost not more than $3,000 complete, exclusive of land and embellishments. There are seven prizes, the first being $200. The contest is open to all materials.

Rules of the competition call for six rooms, with basement under entire house. It is the aim of the committee to obtain designs that are in every way practical; and awards will be made upon this basis. All drawings must be in by Feb. 1.

Instructions regarding the contest may be had by applying to The Complete Building Show Co., 356 Leader-News Bldg., Cleveland, Ohio.

Trade Publications □

The James Way The James Mfg. Co., Fort Atkinson, Wis., board, 7″ x 10″, 256 pp., two colors, illust. This is a valuable book for the farm contractor, published in the interests of James farm equipment. In addition to being a catalog of this line of goods, the book contains a number of barn plans and details that should be of great help to builders.

Cuts Culvert Cost to the Last Cent—The Whalen Form, Syracuse, N. Y., paper, 5" x 8", two colors, illust. This effective catalog, in addition to describing Whalen culvert forms, gives valuable cost data on culvert construction taken from the report sheet of highway superintendents. The cost sheet, both of concrete culvert and metal culvert, are given in facsimile and the data presented should result in the building of many concrete culverts.

Medusa Waterproof White Portland Cement—Sandusky Portland Cement Co., Cleveland, Ohio, paper, 6" x 9", 32 pp., illust. This attractive booklet presents the merits of waterproof white cement for stucco work and includes a very complete set of specifications which cannot fail to be of value to stucco workers. In addition to this there are numerous suggestions for the use of white cement in the manufacture of ornamental products and many buildings are illustrated which should serve as an inspiration for those doing similar work.

Specify Pullman Unit Sash Balances—Pullman Mfg. Co., Rochester, N. Y., specification style, 8" x 11", 8 pp., illust. This unique publication describes the Pullman unit sash balance and its advantages claimed over other methods of balancing windows. A point of especial interest is a metal housing which is provided for use in connection with concrete buildings which does away with any annoyance in providing suitable sockets for the sash balance. Attached to the booklet is a blue print giving window frame details and information necessary for the manufacture of suitable frames for use with these balances.

Bostwick—The Bostwick Steel Lath Co., Niles, Ohio, paper, 9" x 11½", 26 pp., illust. This is a booklet of striking and unusual design. The cover is an embossed two-color reproduction of Bostwick truss-loop metal lath. The catalog describes and illustrates the use of Bostwick sheet metal products very clearly and with unusual detail.

Mosaic Floors—National Mosaic Flooring Co., Mobile, Ala., paper, 6" x 8½", loose-leaf, illust. in colors. This catalog shows about 100 patterns of colored concrete tile, which are made under the name of Adamantile. Full information is given as to quantities needed and methods of laying.

Cement Workers' Tools—Buffum Tool Co., Louisiana, Mo., paper, 7" x 10", 24 pp., two colors, illust. An attractive catalog showing a full line of cement workers' finish tools.

G-F Steel-Tile—An Economical System of Floor Construction—General Fireproofing Co., Youngstown, Ohio, paper, 6½" x 9½", 32 pp., illust. This catalog is published primarily to describe the steel-tile floor system, which consists of special non-removable, light sheet steel forms manufactured by this company.

The book has been planned along the lines of a broad-gauge publicity with the idea of being much more than a catalog. It is, in fact, a book of information for the designer of concrete floors. It contains: a description of G-F steel-tile, well illustrated; specifications for reinforced concrete floors constructed under this system, with sketches showing the necessary form support and typical details; a series of tables, giving safe live loads in lbs. per sq. ft. for 16 combinations of beam and floor slab depth, with proper reinforcing given in all cases; data as to the quantities of material required and the properties of steel-tile floors; formulas on which the tables are based; examples of typical floor constructions, worked out in detail; miscellaneous tables, including weights of various commodities for reference in figuring floor loads, tables of wooden members used in mill construction which make data available for figuring comparative designs; tables showing the weight and area of reinforcing bars and the quantities of concrete required for typical beams and floor slabs are also given, as is a table showing the quantities of material per cu. yd. of concrete. Aside from the value of this publication as a catalog, it is well worth while as a reference work in convenient form.

Handling Sand and Gravel with the Hayward Bucket—The Hayward Co., N. Y. C., paper, 6" x 9", 16 pp., two colors, illust. This catalog is devoted to the use of Hayward clam shell and orange peel buckets, with special reference to the problems involved in handling sand and gravel. A very large number of illustrations give an unusually good idea of various methods available for this service.

Current Prices — Concrete Materials

Portland Cement—There has been practically no increase in cement prices during the past month. Prices given are f. o. b. cars at points named, including cloth sacks, for which, in general, 40 cts. per bbl. (5 sacks) is refunded on return in good condition. Prices per bbl. (including 4 cloth sacks) are as follows: Boston, $1.82; New York, $1.67; Chicago, $1.71; Pittsburgh, $1.71; Cleveland, $1.85; Detroit, $1.80; Indianapolis, $1.84; Toledo, $1.84; Milwaukee, $1.88; Minneapolis and St. Paul, $1.98; Duluth, $1.96; Peoria, $1.79; Cedar Rapids, $1.90; Davenport, $1.80; Toronto, $1.90; Montreal, $2.00; Winnipeg, $2.60; Vancouver, $2.75; Spokane, $2.35; Seattle, $2.40; Portland, Ore., $2.40; Tacoma, $2.40.

Crushed Stone—1½-in. stone, prices per cu. yd., f.o.b. cars in carload lots, unless otherwise specified. New York, 80 cts. to 90 cts., in full cargo lots at the docks; Chicago, $1.15; Winnipeg, $2.75; Vancouver, $1.50; Spokane, $1.00; Portland, Ore., $1.15; Seattle, $1.50.

Gravel—Prices given are per cu. yd. f.o.b. cars in carload lots unless otherwise noted. New York, 80 cts. in full cargo lots at docks; Chicago, $1.15; Winnipeg, $1.85; Vancouver, $1.25; Spokane, $1.00; Portland, Ore., 85 cts.; Seattle, 75 cts.; Tacoma, 75 cts.

Sand—Prices are per cu. yd. f. o. b. cars in carload lots unless otherwise indicated. New York, 45 cts., full cargo at docks; Chicago, $1.15; Winnipeg, $1.85; Vancouver, $1.00; Spokane, $1.00; Seattle, 75 cts.; Portland, Ore., 85 cts.; Tacoma, 75 cts.

Reinforcing Bars—The demand for large size bars for munition manufacture continues and reinforcing bars are becoming a very scarce and highly prized article. At the present time, with deliveries booked for 6 mos. to 7 mos. in advance, it is difficult to see how much early spring construction can be done unless the orders have been placed some time back. The condition is alarming from the standpoint of the engineer, architect and contractor as well as the builder, and orders should be placed for steel at once where work is contemplated for this year. At the present time practically all business is being taken on a basis of $1.80 per cwt., Pittsburgh, with prevailing extras for bars under ¾" or base, and for delivery in 6 mos. to 7 mos., except in special cases. The following are quotations on base bars per 100 lbs., for mill shipments from other points, f. o. b. cars: New York, $1.969; Philadelphia, $1.959; Chicago, $1.982; Spokane, $2.85; Portland, Ore., $2.50; Seattle, $2.50; Tacoma, $2.50.

Shipments from stock are being made at the following prices per cwt. f. o. b. New York, $2.45; Buffalo, $2.45; Cincinnati, $2.45; Cleveland, $2.50; St. Louis, $2.25; Chicago, $2.20; St. Paul, $2.30; Toronto, $2.50; Winnipeg, $2.45; Vancouver, $2.90; Spokane, $3.45; Portland, Ore., $3.15; Tacoma, $3.15; Seattle, $3.15.

Metal Clips for Supporting Bars—$4.50 to $6.50 per 1,000, depending on size.

For the majority of the prices given we are indebted to the Universal Portland Cement Co., Concrete Steel Co., Sandusky Portland Cement Co., American Sand & Gravel Co., Chicago, and F. T. Crowe & Co., Seattle, Portland, Spokane and Tacoma.

Reinforcing bars for mill shipments are in general sold on a Pittsburgh basis: that is, at the Pittsburgh quotation plus the freight to the point in question, and with the following list of freight rates on finished material and the Pittsburgh quotation given, the price of bars at any of the points listed can be readily computed.

From Pittsburgh, carloads, per 100 lbs. to:

Albany	16.9 cts.
New York	16.9 "
Philadelphia	15.9 "
Baltimore	15.4 "
Boston	18.9 "
Buffalo	11.6. "
Cleveland	10.5 "
Birmingham	45 "
Cincinnati	15.8 "
Chicago	18.9 "
Denver	68.6 "
St. Louis	23.6 "
New Orleans	30 "
Minneapolis	32.9 "
Indianapolis	17.9 "
Kansas City	43.6 "
Omaha	43.6 "
Pacific Coast Points (Rail)	73.9 "

Now that the Panama Canal has been opened to traffic ocean freight rates on reinforcing bars to Pacific Coast points have been established which materially lower the delivered cost of bars from the east. The rates per 100 lbs. to Pacific Coast points for large lots are. From Pittsburgh, 61.9 cts.; Chicago, 76.5 cts.; Youngstown, 61.9 cts.; New York, 40 cts.; Bethlehem, 52.9 cts.

Concrete safes are being used as substitutes for the ordinary steel safes. While perhaps not burglar proof, they are fire-proof and are certainly available for safe-keeping of valuable papers or for filing cabinets for mail and other documents in offices of commercial houses. The fire at the Edison plant at East Orange, N. J., demonstrated the feasibility of the concrete safe.

Concrete

Vol. 8 *Detroit, February, 1916* *No. 2*

Silos, Sewers and "Preparedness"

THE silo builder, the pipe manufacturer and every other concrete contractor and manufacturer has two main lines of work—not merely doing a good job, but *getting a job to do.* He must be a salesman. Before his practical knowledge of constructing or manufacturing is tried out, he must "get across" to the public a feeling of confidence in the thing he proposes to make or build. The best ammunition for a salesman is knowledge of what he has to sell. All of this is in the way of pointing out to silo contractors and to sewer contractors and to manufacturers of concrete pipe, that this issue of CONCRETE carries two strong measures of "preparedness." There is the announcement on this page that the "Storrs Bulletin No. 70" has been "repealed" insofar as it was objectionable to builders of concrete silos. Read the statement of the director of the Storrs Agricultural Experiment Station, which makes unanimous the favor in which the concrete silo is held, at least so far as agricultural experiment stations are concerned. Read also and preserve carefully for future reference the mass of testimony as to concrete sewers—the testimony of municipal engineers, presumably unbiased, which clears the way for the more general adoption of concrete sewers in pipe and in monolithic form.

Go To School in Chicago

CHICAGO, for at least a week—from Feb. 12 to 19, will gather to itself, only to spread it abroad to the world, the elements of opportunity in the concrete field. For several years it has been Chicago's privilege to offer a "short course" in the science and the art of concrete. There is good reason to predict that this year's week of schooling is going to be unusually desirable. The Cement Show, opening Saturday afternoon, Feb. 12, is to fill two buildings, instead of one, as formerly, with objects pertinent to the progress of the field and of strong educational import. The convention of the Am. Concrete Institute will begin Monday, Feb. 14, to continue four days; the Road Conference will begin Feb. 15, to continue four days, and the Pipe Association will hold sessions Feb. 17 and 18.

Storrs Agricultural Experiment Station Endorses the Concrete Silo

IN the light of the universal endorsement of concrete silos by experiment stations and agricultural interests in general, the title of this editorial sounds commonplace, yet it is very important in view of the fact that the Storrs Agricultural Experiment Station, Storrs, Conn., has for some years distributed Bulletin 70, an exceedingly able piece of bacteriological research work. Bulletin No. 70, by W. M. Esten and Christie J. Mason, is probably the most complete and valuable treatise available on silage fermentation. So able were the authors in revealing fermentation processes that it is a matter of surprise that in their investigations of the best type of silo for insuring and controlling proper fermentation they should have drawn conclusions in 1912 from statements published in Illinois and Wisconsin bulletins of 1888. Bulletin No. 70 makes statements prejudicial to the concrete silo and endorses the wood silo as having superior curing and keeping qualities. The fact that the instances cited, alleging that concrete failed to keep silage, were dated in the '80's, is enough to show the thoughtful reader that these silos could not have been concrete in a modern sense. While the statements made in the bulletin were objectionable, they were not, in themselves, very harmful because the highly technical nature of the work secured for it a limited circulation only. But since the statements made have been the one official expression available to the opponents of the concrete silo, they have often been reprinted, sometimes in distorted form and in connection with misleading sales literature calculated to carry the idea that experiment stations in general were unfavorable to concrete silos. Great quantities of such literature, often gilded by a local agent of the wood silos, have worked untold harm not only to the advance of the concrete silo but to the farmer, the very man for whose benefit Bulletin No. 70 was issued.

This magazine believed that such a condition would not knowingly be tolerated by the Connecticut Agricultural Experiment Station and took up the matter with the director, Dr. E. H. Jenkins. Proof was submitted to Dr. Jenkins that the station was being placed in a false position and that the modern concrete silo keeps silage perfectly. Part of the proof submitted is from the stations in Illinois and Wisconsin, *the very ones* whose bulletins of a quarter of a century ago were the basis for the Storrs bulletin of 1912. After a study of the facts presented by Concrete, Dr. Jenkins immediately made the endorsement of the concrete silo by experiment stations unanimous in a signed statement to this magazine. Dr. Jenkins writes:

> *If we have further calls for Bulletin No. 70, I shall attach to them a printed copy of the enclosed statement, which you are at liberty to make public if you see fit.*
>
> *Very truly yours,*
> (Signed) E. H. Jenkins.

STATEMENT

The statements made in Bulletin No. 70 of this Station (which appear on pp. 13, 14, 33, 34 and 36 of the Bulletin) regarding the merits of different materials used in the construction of silos do not correspond with the results of more recent experience and experiment.

They were based in part on observations made in silos of primitive construction and totally unlike those in use today.

The experience of owners of silos in this state and elsewhere has shown that silage keeps as well in properly built concrete silos as in one properly built of wood. The choice between the two materials wholly depends on other factors than efficiency in storing and preserving silage.

E. H. Jenkins, Director.
Storrs Agricultural Station,
December, 1915.

The Concrete Silo for Permanence

THE reader will note that Dr. Jenkins refers only to the *silage keeping* qualities of the different types of silos, which is proper, as this is the only phase of the subject discussed in Bulletin No. 70. The last lines of his statement say: "The choice between the two materials (wood and concrete) wholly depends on other factors than efficiency in storing and preserving silage." It is hardly necessary to call the attention of the readers of Concrete to some of the "other factors" which should influence the farmer to choose the concrete structure. Permanence is the watchword of the concrete silo builder. The well built concrete silo can be forgotten by its owner; no repairs are needed; no leaks develop and in case of fire not only the silo but its valuable contents are safe.

To the statement of Dr. Jenkins, that the well built wood silo will keep silage equally as well as concrete, should be added: *so long as it stays well built.*

In actual practice the well built period is exceedingly short. A wood silo salesman at a fair had nearly convinced a farmer that he should buy a wood silo. The farmer asked:

"Can I set up this silo myself?"

A voice from the crowd replied:

"Sure you can, Bill. I've put mine up three times!"

President of the Hill Publishing Company Dies Suddenly

John A. Hill, pres. of the Hill Publishing Co., died suddenly from heart disease, Monday morning, Jan. 24, while traveling in his motor car, from his home at E. Orange, N. J.

In the death of Mr. Hill, the engineering world has lost a man of exceptional power. He was essentially a self-made man; born on a Vermont farm in 1858, he became a locomotive engineer, but his bent for journalism soon called him to the editorship and finally to ownership of the *Locomotive Engineer.*

Seeing the possibilities of the technical press, he added such well known journals as *Power,* the *American Machinist,* the *Engineering News,* and others.

Mr. Hill was affiliated with numerous technical organizations and was one of the representatives of the Am. Soc. of Mech. Engrs. on the recently appointed Naval Board.

Portland Cement Association Will Move to Chicago.

A most progressive step, of consequence to the whole concrete industry, is indicated in announcements of new work to be undertaken by the Assn. of Am. Portland Cement Mfrs., through its new administration, announced in this magazine last month. Preliminary to the execution of extensive plans of development are the change of name to the Portland Cement Association and the early removal of the organization's headquarters from Philadelphia to Chicago, where offices will be in the Conway Bldg., 111 West Washington St.

It is not only the purpose greatly to amplify past policies and procedure, but to "give further emphasis to the admirable policy of constructive co-operation as distinguished from destructive competition," says the announcement. Closer alliance will also be sought with the various associations and organizations concerned in the use of cement and concrete. It is needless to say that the confidence manifested in the future prosperity of the industry will have an encouraging influence upon other industries. Not only the manufacturers of cement, but the public has come to realize that present consumption is small indeed compared with the demand likely to take place in future, and in order that expansion may be as consistent and rapid as possible, exceedingly broad and comprehensive plans will govern future work. This was outlined in a report submitted to the Association by J. P. Beck, formerly of the Universal Portland Cement Co., Chicago. Notwithstanding the fact that it provided for a largely increased appropriation and the exploitation of fields heretofore untouched, it was received with the greatest enthusiasm and adopted without a dissenting voice.

Broadly speaking, the work of the Association upon which special effort will be concentrated will relate to development along three lines, the use of concrete on the farm, concrete roads and concrete in building construction, with special emphasis upon the fire-resisting properties of the material.

Mr. Beck was elected gen. mgr. of the Association, Percy H. Wilson, its former secy., tendering his resignation. The affairs of the Association will be under the control of a governing board. The newly elected officers have already been announced.

Out in California the rare case of a contractor making the mix too rich has just been unearthed in an investigation upon a sample of concrete used by the McArthur Brothers Co. on the Redondo Beach pier. The analysis of the concrete showed a mixture of 1 part cement, 2 parts sand and 2½ parts rock. The contract called for 3 parts of rock and with only 2½ parts, as shown, the mixture is much richer than required. This is one of the white blackbirds that sometimes fly in the skies of concrete construction. (Except that the white blackbird is an albino and a weakling and Nature doesn't let him live long—Editors.)

Methods and Cost of Constructing a Reinforced Concrete Building

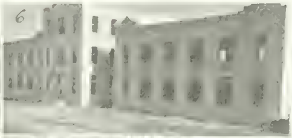
By E. W. Robinson

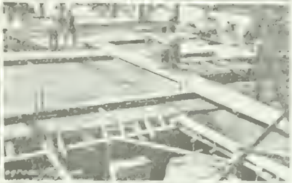
This article describes the methods used and gives the actual unit labor costs attained on the construction of all the concrete work for a brick and concrete building for the Bexar County Home for the Aged, of Bexar County, Tex.

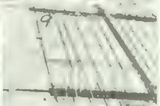
This work is located about 10 mi. from San Antonio and about 2 mi. from the nearest railroad siding, which necessitated camp and commissary for the whole force engaged and, as living conditions undoubtedly had some effect on the efficiency of the men, it can be stated that the camp was different from most construction camps in that no effort was made to realize a profit on the men. Considerable effort was made to make the camp as a whole self-sustaining, but owing to the sudden increase in cost of foodstuffs just as the work was started, which was at the outbreak of the European war, the scarcity of good labor and the usual difficulty of inducing both skilled and unskilled laborers to stay on the job as much as a week at a time, it was allowed to show a deficit at the end. The total loss on the camp amounted to about 4% of the pay-roll, which is believed to have been a good investment, under the circumstances. After the first few weeks excellent labor was secured at the wage being paid in town; the men were kept on the job from Monday morning until Saturday night, had plenty of good substantial food to eat, were fresh and ready to work every morning except Monday, and were well and contented.

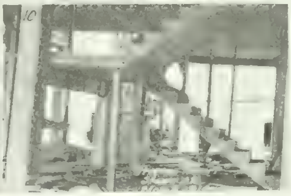
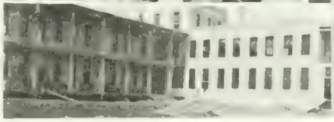
DESIGN

The structural design consisted of beam and slab floors supported by plain square columns. Two sizes of columns were used throughout, 10″ x 10″ and 12″ x 12″.







Figs. 1-6 Progress Views Oct. 15, 1914, to Feb. 5, 1915

Fig. 7 Forms Reinforcing and Runways, First Floor

Fig. 8 Detail of Finished Ceiling

Fig. 9 Detail of Slab Reinforcing and Runway

Fig. 10 Concrete Stairs, Flight No. 2

Most of the beams were 7½″ wide by a total depth of 15″ from top of slab. There were a few beams 7½″ x 12″ and 9½″ x 17″, according to span and loading. The floor slabs are all 4½″ thick and reinforced in one direction with ½-in. twisted bars, except in a few instances, where floors are 5″ thick and reinforced in one direction with ⅝-in. x ⅝-in. twisted bars. Three ⅜-in. round plain bars were used to each panel as ties for the main reinforcing and to take care of expansion and contraction. The roof slab is 4″ thick and reinforced in one direction with ½-in. x ½-in. twisted bars. The columns are reinforced with 4 to 6 plain round bars from ½″ to 1″ in diam., tied with ⅜-in. round spiral hooping. All beam and column reinforcing was assembled at the bench and placed as units. This method allowed a small steel gang to work almost continuously and thus become used to the work, and it was a matter of only 2 hrs. or 3 hrs. to place the steel for a section of floor for a day's pouring.

In addition to the framework there was a basement approximately 39′ x 20′ under one wing, the 10-in. concrete side walls of which took the place of the first floor beams be-

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[1]Chf. Engr., McKenzie Const. Co., San Antonio, Tex.

tween columns. The three wings of the building are two stories, the central part is three stories high. There are three flights of concrete stairs between the first and the second floor and one flight between the second the third floor.

BUILDING AND SETTING FORMS

Forms for the sides of the columns were made at the bench to the proper size. They were made a few inches longer than net height between floors and the bottom only was squared. The sides were assembled with 1¼-in. chamfer strips nailed in the corners and after having been well oiled with a paraffin oil were nailed with double-headed draw nails[2] just enough to hold them together while being set. The bottom ends of the forms were set into pockets consisting of four 1-in. x 3-in. strips located by a transit and tape and nailed to the concrete before it set hard. Forms were then made plumb in both directions, cross-braced and tied together. As soon as one section of column forms had been set, consisting usually of one wing or the central part of the building, points were marked near the upper and a certain distance below top of floor above by means of a "Y" level and inverted rod. As these points were set from an established permanent bench mark each floor was at the proper level, entirely independent of inequalities in the surface of the concrete of the floor below. The foreman then marked the sizes of the beam openings on the sides of the column forms, also the depth of floor slab at that point. Except in unusual cases this gave sufficient information for the carpenters following. As soon as one squad of carpenters finished the column heads another squad followed, setting beam bottoms and built-up beam sides. The beam bottoms were of 2-in. material and the sides were fastened to them by means of 8d double-head draw nails.

Floor Forms—The 2-in. x 6-in. joists and the 4-in. x 4-in. stringers and shores were next placed. The final operation was to place the 1-in. x 8-in. shiplap and to finish the corners with chamfer strips. As shown at Fig. 12, the joists were not in one piece from beam to beam, but were cut in the center and lapped on a 4-in. x 4-in. stringer which was carried by the shores. This provided for ease in wrecking and saved lumber. The shores were cut to proper length on the power saw and after the shore head had been attached to those that went under beams, were placed by two or more helpers under the supervision of a carpenter.

It was at first thought advisable to make the slab forms in panels, but owing to the comparatively small number of panels of exactly the same size this method was abandoned in favor of the method outlined above. Instead of using two or more size of shores according to the loading and having all spacing equal it was thought better to use one size of shores and vary the spacing. The reason for this was principally because there is always a better demand for second-hand 4-in. x 4-in. material than for 6-in. x 6-in. or larger. Column sides and beam sides were extended or cut down as was necessary when they were reused, and were used from three to five times and could have been used several times more had the building been larger. The shiplap flooring was used on an average three times before it was ready for the scrap pile. Just before the steel was placed the forms were swept clean and well oiled with a paraffin oil.

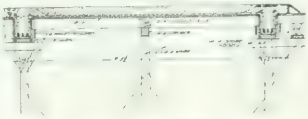

FIG. 12—DETAIL BEAM AND SLAB CONST.

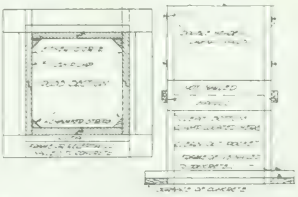

FIG. 13—COLUMN DETAILS

The covers to column clean out pockets were not replaced until just before the concrete was poured.

Seven adjustable steel column clamps[3] were used on each column, spaced from the bottom upwards as follows: 12″, 12″, 15″, 20″, 20″, 22″, 24″. This spacing held the forms true, notwithstanding the fact that the concrete was pretty wet and poured as fast as it could be well worked around steel.

The labor cost of erecting forms as given later includes the carrying of material to the erectors, cleaning and oiling and the cost of placing clamps, in fact, everything ready for the steel and concrete. The cost of wrecking includes the cost of pulling nails, sorting and cleaning and piling ready for the men who carried to the erectors.

The following tabulation gives the total bill of lumber brought onto the job:

1″ x 8″	S. L.	37,275′	B. M.
1″ x 4″	Box.	400′	"
1″ x 4″	"	1,677′	"
1″ x 6″	"	1,496′	"
1″ x 12″	"	2,500′	"
	Mostly in tool sheds, etc.		
2″ x 4″		3,872′	"
2″ x 6″		7,960′	"
2″ x 8″		3,288′	"
2″ x 10″		1,980′	"
	Mostly for run-ways		
2″ x 12″		1,700′	"
	Mostly for run-ways		
4″ x 4″		9,392′	"
Total		71,540′	B. M.

Of this total there were about 36,000 ft., B. M., left in shape fit to be used again on rough work, excepting the 4-in. x 4-in. material, which in the longer lengths was as good as new. The short pieces of 4-in. x 4-in. stuff have already been used for trench braces on another job, so practically full value has been, or will be, secured for nearly all of that dimension. The above material does not include lumber for finish work in the building, or for

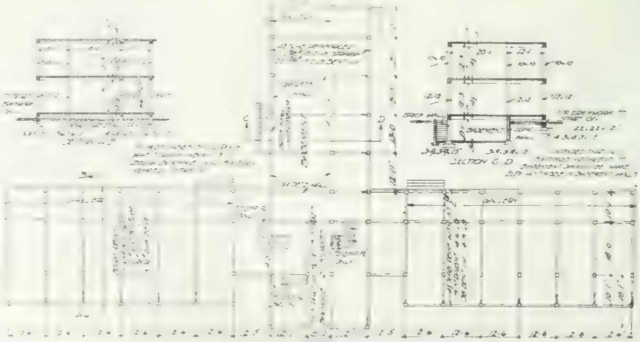

FIG. 11—FLOOR PLAN AND SECTIONS, BEXAR CO. HOME FOR AGED

any other purpose after the concrete was finished.

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[2] F. A. Neider Co., Augusta, Ky.

[3] Symonds Clamp Co., Chicago

The following quantities of nails were used in the forms:

4d	200 lbs.
6d	700 "
Used on sheathing	
8d	500 "
Includes double-head draw nails	
16d	300 "
Mostly in tower	
60d	100 "
For fastening column clamps	
Total	1,800 lbs.

CONCRETE PLANT

All concrete for the building was mixed in a one-sack batch gasoline-driven Austin cube mixer.[4] For the ground floor and basement the concrete was wheeled in 5-cu. ft. Ransome carts[5] direct from mixer to forms. Above the first floor the concrete was hoisted up a tower and poured down one section of a Wylie chute[6] into a wooden hopper from which the carts were filled. A 5-in. x 7-in. double-cylinder double-drum steam hoist was used to handle the bucket in the tower and also to operate a boom fastened to one side of the tower for raising material, carts, runways, etc., from floor to floor.

The Tower—The tower consisted of four 4-in. x 4-in. corner posts spaced 48½″ x 44½″ o. c. with 2″ x 6″ horizontally, dividing it into 14 panels 6′ high. Each panel was cross-braced with two 1-in. x 8-in. boards on each side. The guides for the bucket were made of material 2″ x 4″, 2″ x 6″ and 2″ x 12″. With common labor at 25 cts. and carpenters at 45 cts. and 47 cts. per hr., the total cost of erecting tower ready to run concrete, including guying and rigging, was $1.08 per vertical ft. This cost was divided as follows. The actual cost of building plain tower without guides, including all sawing, hauling up with ropes and placing, was:

Two carpenters, 42 hrs. @ 47 cts.	$19.69
One helper, 22 hrs. @ 25 cts.	5.50
Total, 84 vert. ft. or 1,241′. B. M.	$25.19
Per vert. ft.	$ .30
Per M. B. M. =	20.30

The cost of making and placing cat head, placing sheaves, and placing guides for bucket was:

39¼ hrs. @ 47 cts.	$18.39
10¼ hrs. @ 45 cts.	4.61
17¼ hrs. @ 25 cts.	4.30
Total	$27.30
Total tower cost, exclusive of guying and rigging	$52.49
Cost per vert. ft.	.626
Cost per M. B. M. of lumber	28.30

The rest of the cost was for guying and rigging ready to run concrete, and for excavating about 8 cu. yds. of earth for deadmen and hole for bucket at bottom of tower. Four ⅜-in. cable guys were placed about the center of the tower and 4 more at the top. The cost of wrecking the tower was about $8 for everything, as the tower was felled instead of being taken down piece by piece.

All materials were placed as close to the mixer as was possible with single teams. All concrete except columns was 1:2:4. Fine bank sand and round screened river gravel were the aggregates used. An average size gang for pouring concrete on second floor, with runways from 10′ to 75′ long from hopper, was as follows:

Ground

1 hoist man
2 mixer men
1 feeding cement
2 wheeling sand, 40′ to 50′
4 wheeling gravel, 20′ to 50′
1 wheeling gravel and carrying cement, 40′

Top

1 at hopper
4 wheeling carts
1 dumping carts and moving runways
2 dragging off and removing screeds
2 placing and tamping around reinforcing

The reason for two men at the mixer was that the throat of the loading skip was so small that too much time was lost in waiting for the whole charge to get into the drum, so one man did nothing but punch the charge out of the skip. By timing 15 or 20 batches it showed an average of about 47 sec. per batch when there were no delays. When one whole section of about 52 cu. yds. was poured in 4 hrs., as was done several times, it was considered a pretty good run.

The carts used to distribute the concrete over the floors were run on runways built up in sections 4′ wide and 12′ or 14′ long of 2-in. x 10-in. or 2-in. x 12-in. lumber. Short 4 x 4's were used for legs to keep the planks clear of the reinforcing steel. Four men could easily handle one section even when wet and covered with concrete, and very little time was used in shifting runways.

CONCRETE COSTS

Practically all common labor was paid 25 cts. per hr. for 8-hr. das., though two leaders received a few cents more and a few men were paid 20 cts. All but three carpenters received the union scale of 45 cts. per hr., and these three leaders received 47 cts. Carpenter helpers received 25 cts. per hr. and were furnished with saw and hammer. A small combination machine driven by a gasoline engine did the sawing and ripping. The man who ran this machine also ran the steam hoist and received 50 cts. per hr. The mixer man was an all-around machinist, did blacksmith work and machine repairing and received $3.50 per da., straight time. One foreman received $4.00 per da., one $5.00 per da., and the superintendent $30 per wk.

In keeping the cost data a check was made against the actual pay-roll each week, and any discrepancies found were corrected before it was too late for some one on the job to remember what a certain man did on a certain day. In this way while any particular item may be in error a small amount, the total labor cost is correct, as it has to balance the actual pay-rolls. Each man's time was charged to some item on the schedule for each and every hour he worked. Most of the supervision, the waterboy, and such time as was devoted to the job as a whole and could not be charged to any particular thing, was placed under "General" and kept as a separate item. The following unit costs do not include this item of "General" and to obtain the total field labor cost one should add 16% to the costs as given. The writer realizes that this method is not exact but he believes it is as well to handle general expense in this way as by any other method.

The concrete labor was divided into two items, that of "Preparing Plant" and "Mixing and Placing." The former includes all labor getting ready to run concrete, and includes the cost of building and rigging the tower, etc., while the latter is simply the actual cost of mixing and placing. In this case, which is typical of the writer's experience, the item of Preparing Plant is approximately ¼ of the total cost of concrete labor, and he believes that some of the low record costs of pouring concrete he has heard of are due to neglect of this very important element of cost.

There were 780 cu. yds. of concrete in the building and 56,032 sq. ft. of form area. There was a total of 63.8 tons of reinforcing steel used, of which 21.7 tons was delivered on the job bent and required only assembling and placing, and 32.1 tons required bending, assembling and placing.

The actual unit labor costs of the above item are as follows:

Preparing plant	$0.265	per cu. yd. concrete
Mixing and placing	0.756	per cu. yd. concrete
Total	$1.021	per cu. yd. concrete
Rorms, bench work	$0.405	per cu. yd. concrete
Forms, bench work	0.006	per sq. ft. forms
Forms, erecting	2.350	per cu. yd. concrete
Forms, erecting	0.033	per sq. ft. forms
Forms, total erect'g	$2.755	per cu. yd. concrete
Forms, total erect'g	0.039	per sq. ft. forms
Forms, wrecking	$0.492	per cu. yd. concrete
Forms, wrecking	0.007	per sq. ft. forms
Total form labor	$3.247	per cu. yd. concrete
	$0.046	per sq. ft. forms

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[4] Municipal Engrg. and Contrg. Co., Chicago

[5] Ransome Concrete Machy. Co., Dunellen, N. J.

[6] J. S. Wylie, Chicago

The above concrete cost data include cost of stairs, but they were kept separate as far as was possible so as to secure separate cost data. The cost of concrete could not be separated, as stairs were poured at the same time the rest of the floor was poured, but the cost of forms and steel for them was as follows:

No. 1—21 steps each 4′ 6″ wide, 2.81 cu. yds. concrete, 0.1464 tons steel and 202 sq. ft. of forms.

Erecting Forms

15 hrs. @ 47 cts.	$7.05
13.5 hrs. @ 45 cts.	6.08
15 hrs. @ 25 cts.	3.75

Per sq. ft. of forms = 0.0835
Per cu. yd. concrete = $6.01

No. 2—21 steps each 4′ 6″ wide, 3.19 cu. yds. concrete, 0.1939 tons steel and 227 sq. ft. of forms.

Erecting Forms

13 hrs. @ 47 cts.	$6.11
13.25 hrs. @ 45 cts.	5.96
13 hrs. @ 25 cts.	3.25
Total	$15.32

Per cu. yd. concrete = $4.80
Per sq. ft. of forms = 0.0675

No. 3—21 steps each 3′ 6″ wide, 2.35 cu. yds. concrete, 0.1368 tons steel and 176 sq. ft. of forms.

Erecting Forms

28.75 hrs. @ 47 cts.	$13.51
7 hrs. @ 45 cts.	3.15
Total	$16.66

Per cu. yd. concrete = $7.09
Per sq. ft. of forms = 0.0947

Nos. 1, 2 and 3. One carpenter at 47 cts. and one helper at 25 cts. per hr. bent and placed all steel for all three flights at a cost of $18.43 per ton.

Different squads of men worked on these stairs, which explains to some extent the differences in cost. The reason is very plain why No. 3 should be higher than the rest, as the men had no helper to bring them material and do the rough work.

All stair steps had nosings or curb bars[7] placed in the edges of the steps and the cost of fastening these in place in the forms for 33 @ 3′ 6″ and 42 @ 4′ 6″, or a total of 75 pieces and 314′ 6″ was as follows:

5.75 hrs. @ 47 cts.	$2.70
3.5 hrs. @ 45 cts.	1.58
5.25 hrs. @ 25 cts.	1.30
Total	$5.58

Per step = $0.0744
Per lin. ft. = 0.0177

As there are generally a large number of stirrups and column hoopings to be bent on a job of this sort separate costs were kept on these items under average conditions when it was possible to separate them. In bending the stirrups in one man at 25 cts. per hr. in 6.5 hrs. bent 350 stirrups, all of 3/8″ sq. tw., half of which were 3′ 4″ long and the other half 3′ 7″ long. This is at a cost of $5.602 per ton or a cost of $0.00116 per bend. It will be noted there two right-angled bends and two bends of about 135° to each stirrup.

Column hooping was bent from 3/8-in. round steel and was bent around a square wooden shaft of the proper size, the edges of which were reinforced by steel angles, and which was turned much in the same manner as an old-style windlass. One man turned the shaft and another hammered the rods to proper form with a heavy machinist's hammer or a light striking hammer. The cost of this work was as follows:

3 hrs. @ 30 cts.	$0.90
3 hrs. @ 25 cts.	.75
Total	$1.65

Bent 15 hoops around a 10 in. x 10 in. shaft, 10 turns to a hoop at a cost of 11 cts. per hoop or $17.56 per ton.

A little later when these same men became more accustomed to this work in 5.75 hrs. they bent 48 hoops around an 8-in. x 8-in. shaft, with 10 turns per hoop (each was in three pieces also) at a cost of $0.0663 per hoop, or a cost of $13.25 per ton.

In both the column and the stirrup costs the seeming high cost per ton is of course due to the small weight of the 3/8-in. material.

The cost of placing the steel column clamps was kept in a few cases and was found to be as follows:

For placing clamps 2-7, incl. (from bottom up), 13 columns:

10.5 hrs. @ 30 cts.	$3.15
15.5 hrs. @ 25 cts.	3.85
Total	$7.00

Per clamp = $0.089
Per column = 0.538

Same as above, but on five columns and with carpenters doing the work:

2 men, 2.5 hrs. @ 45 cts.	$1.13

Per clamp = $0.0377
Per column = 0.226

Placing clamp No. 1, including replacing cover to clean-out pocket on 28 columns:

3 hrs. @ 47 cts.	$1.14
2.25 hrs. @ 45 cts.	1.01
4.75 hrs. @ 25 cts.	1.20
Total	$3.62

Per clamp or column $0.129

One man at 30 cts. per hr. removed Nos. 1, 3, 4, 6 from 8 columns in 1.5 hrs. at a cost of $0.014 per clamp.

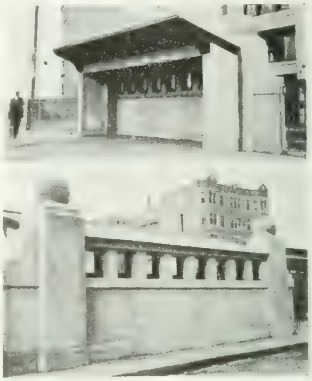
It is shown above that the carpenters could place the clamps considerably cheaper than the common laborers, though receiving nearly twice the pay, for the reason that they were used to using their tools, and were mechanics. There is no doubt that after long practice the laborers could do the same work in the same time as the skilled men. This illustrates in a small way the value of a man skilled in any particular work and is only one of the many things that show an observer that the wage paid a man is not the only consideration in determining whether or not he is wanted on the pay-roll.

The architects on the above building were Alfred Giles Co. and Chapman & Murphy,[8] and the structural engineer Willard Simpson.[8] The work was done by the McKenzie Const. Co.[8]

Railway Shelters

Two reinforced concrete shelters for waiting passengers at the western entrance to the Boylston St. tunnel, Boston, have been constructed by the Boston Elev. R. R. Co.

The shelters are 25′ 4″ long and 5′ 2″ wide and have a sloping roof overhanging 3′ 4″. The sides and the back—which has the external appearance of a wall, viewed from the street outside the enclosure, and is in line with the iron fence which extends around the prepayment area—are of reinforced concrete.



Passenger Shelter, Boston Elevated Ry.

The corner posts, which are 2′ 6″ x 2′ 6″, are constructed of brick piers, stuccoed. The top of each post is surmounted by a concrete ball. The roof is of 3-in. x 6-in. hard pine rafters, 1⅛-in. matched hard pine boards and a slate covering. All the concrete is given a slap-dash finish.

The use of concrete for buoys and mooring blocks is by no means new, but according to *Concrete and Constructional Engineering,* a rather unique method is being adopted in England for making mooring blocks. A concrete buoy is first constructed consisting of a thin shell heavily reinforced. This, after curing, is towed to position and scuttled. A diver then fills the buoy with stone or scrap iron, forming a substantial anchorage. The advantage of this construction is that it allows the anchor to be constructed in a convenient place and towed to position and placed without heavy equipment.

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[7] Trussed Concrete Steel Co., Youngstown, Ohio.

[8] San Antonio, Tex.

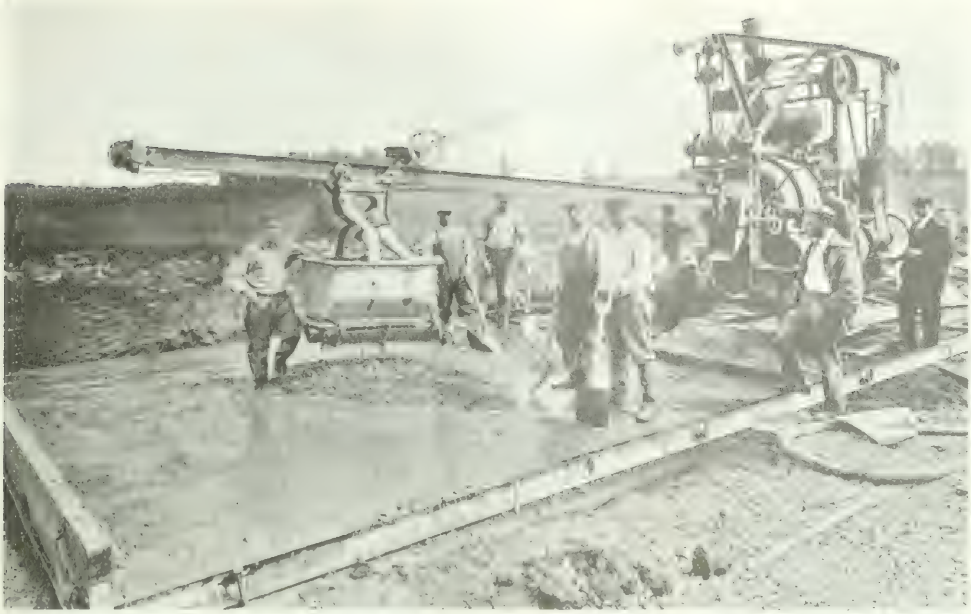

Fig. 1—Placing Concrete on Allentown-Easton Road

Advanced Practice With Economical Results on the Allentown-Easton Road[1]

The Pennsylvania State Highway Dept. is constructing a concrete road between Allentown and Easton, which it is proposed to make representative of the highest standard of modern engineering practice in concrete highway construction. The road is 16′ wide and will be approximately 12 mi. long, between Allentown and Easton, via Bethlehem, thus connecting three important towns in the Lehigh cement region.

While the road is being constructed in conformity with the most exact engineering requirements, it will be built as economically as possible, for the Highway department intends to demonstrate that the methods employed are so thoroughly practicable as to be applied to any concrete job.

Up to the time when work stopped for the season the scene of operations was a busy one, with its camp of several hundred laborers and big outfit consisting of road rollers, stone crushers, mixers and the many minor tools and appliances required for this type of construction.

The work began half-way between Easton and Bethlehem and was pushed in each direction by two completely equipped crews. About 4 mi. have been graded, 3 mi. sub-graded and about 3½ mi. concreted.

Special attention has been given to the economical arrangement and distribution of materials. The stone is loaded directly into the cars of the Easton Transit Co., at Bethlehem, and at a small quarry opened by the state. The sand for the road is dredged material from Succassunna, N. J. It grades from thoroughly fine to pea gravel, and having been dredged, is very clean. The stone used is Dolomite. The cement is stored in portable canvas sheds holding 90 sacks each. These are placed at measured distances along the road and are carried ahead as they are emptied. Accurate measuring of the sand and stone is done with wood box-barrows of special design and of 3 cu. ft. capacity. The materials are struck off with a shovel. The box-barrow is shown in an accompanying detail. They were designed by the Assn. of Am. Portland Cement Mfrs.

One No. 16 Koehring mixer[2] of 3-bag batch capacity and with boom delivery is used at each end of the concrete work. Side forms[3] are made of 6-in. channels in 12-ft. lengths. They are held in place by steel pins.

The finished concrete is 6″ thick at the sides and 8″ thick at the center. It is laid on a level sub-grade, which is sprinkled with a hose before the concrete is placed.

The road is being reinforced with No. 25 Kahn[4] road mesh in sheets 5′ 2″ wide and in lengths of 6′ and 10′. It is laid with the lengthwise joints staggered and with a lap of 4″ transversely and 12″ longitudinally of roadway.

The expansion joints are 39′ 6″ apart, made by tying two 9-in. x 16-ft. strips of ⅛-in. Elastite[5] to a 9-in. x 16-ft. plate, this assembled form being securely placed with the

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[1] Courtesy Assn. of Am. Portland Cement Mfrs.

[2] Koehring Machine Co., Milwaukee

[3] R. D. Baker Co., Detroit

[4] Trussed Concrete Steel Co., Youngstown, Ohio

[5] Philip Carey Co., Cincinnati, Ohio

Figs. 2 and 3—At Left Crushing Stone and Filling Side Drains; at Right, Box-Barrow for Accurate Measuring of Concrete Materials

Elastite next the slab which is being finished. Concrete is poured on both sides of the joints. That on the back side is struck off and the strings are cut and the plate pulled out by handles, leaving the joint clear. After the concrete has hardened for 24 hrs. the joint material is trimmed off ½″ above the concrete surface.

The concrete crew is organized with three finishers, two men who handle both strike boards, three men placing concrete and reinforcing, one mixer engineer, one fireman, one charging man, two men on forms, three men on cement and from eight men to 12 men on stone and sand. Although every batch is mixed 90 sec., a crew can place more than eight slabs in a 10-hr. day, making more than 100 cu. yds. of concrete. Seven slabs can be run normally.

CONSTRUCTION FEATURES

Prolonged Mixing—Among the construction features of the road of special interest are the thorough compacting and under-draining of the sub-grade and the strict adherence to established grades. Every batch of cement is mixed 1½ min. and sufficient water is used to make the concrete plastic, so that it does not quite level down in the discharge bucket.

Joints—On the theory that cracks are of surface origin in unreinforced concrete, the slab length has been increased to 39′ 6″. The steel road mesh reinforcement placed 2½″ from the top of the slab is used to eliminate longitudinal cracks caused by the settlement of shoulders.

Surface—An extra heavy strike board, followed by a lighter one, insures the thorough compacting of the concrete and eliminates the formation of rolls in the surface. The broomed finish has been discarded in favor of the wood float. At the expansion joints a 3/16-in. radius edger is used and at the sides a ¾-in. radius edger. This is expected largely to eliminate chipping.

Tests—Tests of eight cubes a week are taken from the output of each mixer. Cubes are tested at 7 das., 14 das., 28 das. and 6 mos.

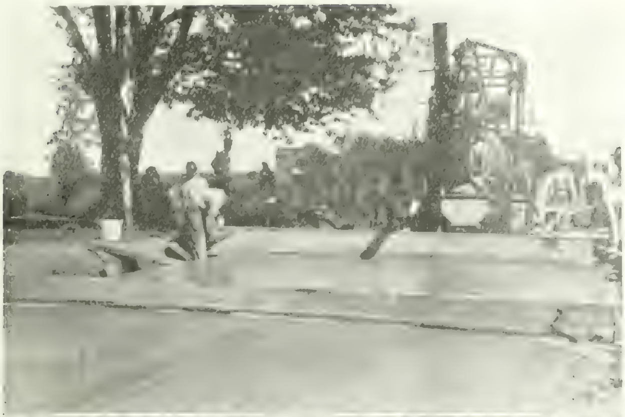
Local Materials for Aggregate—Full use is being made of the resources of the territory through which the road passes in order to secure the cheapest acceptable road materials. Road machinery in the most economical units is also being used. The trolley line parallel with the road distributes the cement, sand and stone. At the small quarry midway between Bethlehem and Easton two portable crushers are used and the bins discharge into the cars on a spur from the trolley line. This quarry is supplementing the available supply of commercial stone and cutting cost. The tailings and fine stone from the crushers are used in drainage ditches and on the shoulders of the finished road. The rock excavated in grading is crushed in a portable, gasoline-driven, coffee-mill crusher and is used to cover the tile drains laid in advance of concreting.

After the rough grading is done the sub-grade is finished and rolled while the drains are being put in. The concrete crew, the finishing crew and the curing work follow in order, after which the earth used to cover the concrete is utilized by the trimming-up gang.

Special attention is paid to the proper distribution of concrete materials and rehandling has been practically eliminated. The sand and stone cars are stationed by the foreman at measured distances from the end of the last concrete. The men are distributed with care to insure the uniform progress of each operation from the rough grading to the finishing of the shoulders.

Drainage—The present road bed is in clay, mostly without heavy cuts or fills. All fills are made in 1-ft. layers and well rolled with a 10-ton roller. Adequate longitudinal and transverse porous tile under-drains are being installed. Corrugated iron pipes are used to convey water under the road bed where necessary and concrete box-culverts are built in advance of concreting to care for small streams and heavy watersheds. The side drains are of 4-in. porous tile and are laid on a ½-in. x 4-in. board to maintain an even grade. They are set 24″ below subgrade and laid with a covering of one-ply tar paper wrapped around each joint, with no lap on the bottom. This paper contains little tar and will allow easy ingress for the water at joints. This method is considerably stronger and is expected to last longer than the bagging generally used. The ditches are backfilled with tailings from the crusher plant and with stone from the grade cuts. The cuts and fills are light, in most cases little more being done than to remove the old surface. This material is loaded by hand and distributed in dump wagons.

Sub-grade—Grade stakes are set every 25′ and the sub-grade accu-



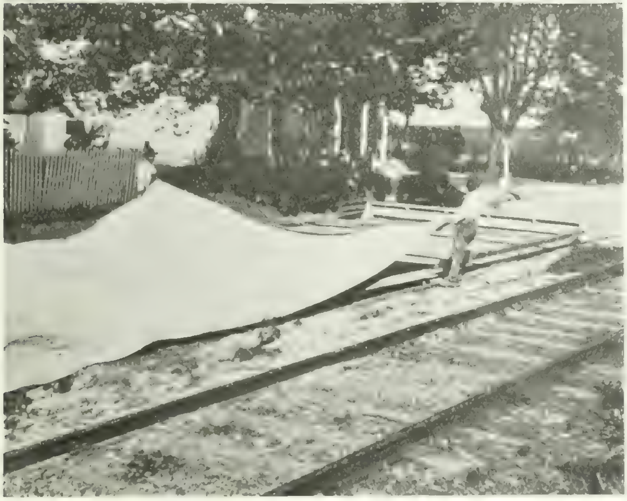


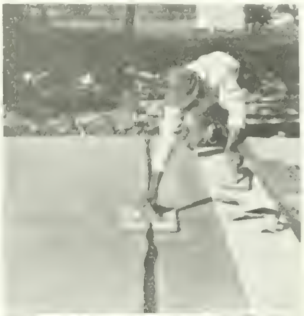
Fig. 7 -A Light (Foreground) and a Heavy (Background) Template Are Used
Fig. 8—Covering Freshly Finished Concrete with Canvas, Over a Frame

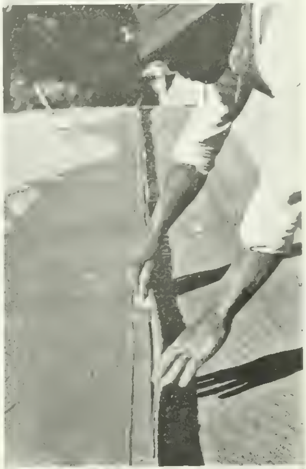
rately finished. It is rolled until it no longer swells under the roller. Although an effort has been made to spend no more money on this work than the saving of concrete justifies, a majority of the slabs have been laid with less than 4% variation from the theoretical volume, and several have run the exact computed yardage.

Curing — The fresh concrete is covered with canvas. A strip of canvas 19′ wide and 50′ long is rolled around a length of 2-in. pipe. Frames are then stuck in the shoulder of the road on each side, being supported by the steel strap stakes bent at intervals around the 2-in. x 3-in. wood runners of the frame. Across the road 12′ to 14′ apart are laid 2-in. x 3-in. pieces, 17′ long, resting on the frames on each side. Canvas around the pipe is then laid across the road and unrolled over the frame. This device, worked out by the engineers of the Pennsylvania State Highway Department, can be taken up and reset in a short time and is especially useful during rainy weather. It keeps the canvas in good condition and prevents it from being dragged over the ground or the green concrete.

Under a very hot sun the fresh concrete is, as stated, protected by the canvas. On cool days it is simply wet occasionally with a hose. After 24 hrs. the forms are removed and the surface covered with a few inches of earth. This is wet night and morning for 10 das. and after 14 das. it is removed and placed on the side slopes as needed. All traffic is kept off the sub-grade and the delivery of materials by trolley line makes it unnecessary for even construction wagons to use the subgrade when finished. This also keeps the rollers about a half mile in advance of the concrete crews.

Cement Shelters — Eighteen-oz. canvas stretched tight and tacked with roofing nails over a frame of 2-in. x 4-in. studs and 1-in. plank makes a waterproof portable cement house, which has solved the cement storage problem and eliminated rehandling.





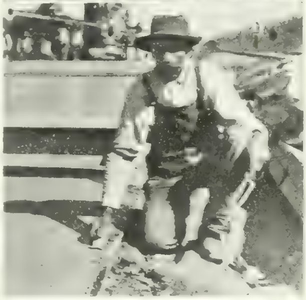


Fig. 4 Use of Split Float
Fig. 5 -Use of Edger Next to Joint Filler -New Construction Feature
Fig. 6—Use of Edger Next to Side Forms

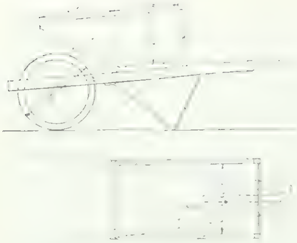


Fig. 9—Details of "Box-Barrow"

The road is being built under the direction of W. D. Uhler, chf. engr. of the Pennsylvania State Highway Dept., and George H. Biles, Second Deputy Highway Commr. J. T. Gephart, Jr., is acting engr. of the district and J. E. Sampson, supt.

Test of Concrete Piles at Long Island City

An interesting test of pedestal concrete piles[1] has just been carried out at the foundation of a building for the American Druggists Syndicate, Long Island City, N. Y.

Complying with the wish of the building department of the Borough of Queens, a group of four concrete piles were driven on 3-ft. centers through a soil consisting of a surface fill of trash underlaid by a thick stratum of marshy muck into hard sand. Each pile was approximately 20′ long and was driven to a resistance of 8 blows per in. with a No. 2 Vulcan steam hammer.[2] Standard methods and equipment were used and the total time required to drive the four piles was 2 hrs. As shown by the illustration, the piles were excavated to a depth of about 14′ in order to allow complete inspection. It will be noticed that the piles are straight and cylindrical and of uniform cross-section, and that the spacing has been maintained throughout their depth.

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[1] MacArthur Concrete Pile and Foundation Co., N. Y. C.

[2] Vulcan Iron Wks., Wilkesbarre, Pa.

Excavation Exposes Concrete Piles

Construction Methods on the Toronto-Hamilton Concrete Highway

The construction of the Toronto-Hamilton Highway is of special interest because it is an unusually long stretch of road to be under construction with concrete at one time, with work being carried on from four points, using an industrial railway for hauling materials. The accompanying data came to Concrete *from H. S. Van Scoyoc, chf. engr., Toronto-Hamilton Highway Commission. Mr. Van Scoyoc is to present a paper at the convention of the Am. Concrete Institute in Chicago this month, with special reference to the day labor plan on the construction of this road.*

The Toronto and Hamilton Highway Commission is constructing a concrete highway from the city limits of Toronto (a city of over 500,000 population) to the city limits of Hamilton (having a population in excess of 100,000), these two cities being the largest in the Province of Ontario.

Although the highway had been contemplated for some time, it was begun as a relief measure to provide work for the unemployed in the two cities and in the territory through which the road passes. For this reason it is being carried forward on a day labor basis.

The money is provided by the issuing of debentures guaranteed by the provincial government, which will be replaced at the end of five years, when the Commission receives a share from each municipality as shown by the construction costs. The city of Toronto has contributed $150,000 and the city of Hamilton $30,000. The provincial government has contributed not to exceed $4,000 per mi. of highway and the various municipalities traversed by the road are contributing on the basis of $4,000 per mi. The remaining cost is to be provided for on a frontage assessment.

The standard section of concrete is 18′ wide, the thickness at the edge being 6″ and at the center, 8¼″.

In order to carry out the work, three yards have been constructed, one at Port Credit, one at Oakville and one at Waterdown, from which the materials are being distributed on the highway by an industrial railway.

Up to November, grading on 30 mi. of the highway had been completed and about 15 mi. of concrete has been placed. The right of way over the highway is at least 66′ wide. Ditches have been given a slope of 1½ to 1. The maximum grade is 4% and the radius of the sharpest curve is in excess of 200′. The concrete is being mixed in six cube mixers, five of them having ½-yd. capacity and one of them having ⅓-yd. capacity.

Investigation showed that the average haul would likely be about 3 mi., with the extreme being about 8 mi. Team hauling, motor truck hauling, tractor with trailers and industrial railway were all considered. As the hauling would all have to be done over unimproved roads, a great many of them sand roads, and others clay, it was felt that the advantage would lie with the industrial outfit.

Locomotives, three in number, are of the Continental type,[1] and there are 120 dump cars of 36 cu. ft. capacity, 24-gauge.[2] Track sections with rails[3] and steel ties[4] were assembled in the Commission's own yards.

The Commission purchased five cube mixers. As far as possible these machines were made in Toronto, although some of the parts were shipped from Chicago and assembled in Toronto. These machines are all of the ½-yd. size, holding 22 cu. ft. of loose material. In addition the Commission has had the use of one ⅓-yd. paver, the property of the Department of Public Works for Ontario.

The sub-grade is flat for the standard width of 18′ and slightly crowned on widths greater than 18′, to avoid excessive thickness of concrete in the center in maintaining the crown.

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[1] Canadian H. K. Porter Co., Toronto (H. K. Porter Co., Pittsburgh)

[2] Dominion Wheel & Foundries Ltd., Toronto, Ont.

[3] Algoma Steel Co., Sault Ste. Marie, Ont.

[4] U. S. Steel Products Co., Toronto, Ont.

[5] Lecky & Gollis, Toronto, Ont.

The specifications require that, where the sub-grade is impervious, it shall have a 4-in. covering of pervious material before finishing to receive the concrete.

The road is being reinforced where wider than 18′ and over especially poor sub-grade.

Concrete is made from hard, tough limestone, showing a satisfactory abrasive test, of a size to pass a 2-in. ring and be retained on a ¼-in. screen; coarse sand and Canada Portland cement.[6] Proportions in general are 1:1½:3, with slight variations, depending upon grading of stone, but with never more than a slight excess of mortar in the mix. Water is brought by the Commission's own pipe line and pumps from Lake Erie.

Concreting has been carried on from four points, in one case three of the mixers working from one of the bases. For the roadway proper, six concreting gangs have been employed and for the culvert work three additional gangs.

The industrial railway does not bring up the material in quantities for batches. Sand and stone are dumped on the grade and rehandled.

A gang is organized about as follows: Behind the mixer, shovelers and wheelers handle the sand and stone from the sub-grade to the loading skip.

Each batch is left in the drum for at least 45 sec., although no special timing device is used on the mixer.

A rather stiff consistency is desired which will flow freely into place but in which there is not any tendency for the coarse aggregate to separate from the mass of concrete.

The concrete is deposited by boom and bucket, the bucket being of the overturning rather than the bottom-dumping type.

After being deposited it is leveled by means of hoes and spades, a strike-board passed over it, first with a tamping action and again with the intention of giving it the correct crown and following that, two floaters working from bridges complete the finishing operation.

In handling the strike board it is worked forward to within 3′ of a transverse joint, when all excess material is removed and the strike is then lifted to the joint and worked backward—not toward the joint. The specifications call for special care in getting a good [illegible] 6″ each side of a joint.

Joints are placed every 35′. The filling material consists of a bituminous material enclosed in felt impregnated with a bituminous mixture. The strips of material are about ¼″ thick.[7] No metal protection plates are being used.

Wood floats are used in finishing and the specifications require that the finishing shall be completed just as the concrete is beginning to "catch."

At the joints a split tamper, as well as a split float, is being used in an endeavor to have both sides of the joint at the same elevation.

Steel side forms are placed and removed by a special gang, which also does fine grading some distance ahead of the mixing gang, preparing the sub-grade to receive the materials. This same gang usually places the covering material for curing purposes. In warm weather the work has been covered with tarpaulins carried on frames, just as soon as a section has been floated.

After 24 hrs. a 2-in. covering of earth has been used, the earth being sprinkled a number of times each day for a period of 10 das. The earth protection remains in place until the road is opened for traffic, a period of at least 21 das.

Up to the present no hydrated lime has been used in the mixture but probably a small section will be laid with hydrated lime during the next year's work.

Portland Cement or Plaster Mixtures Modeled by New York Sculptor

A patent has been applied for by Angelica Schuyler Church, a sculptress of N. Y. C., on a new method of direct modeling with plaster or Portland cement. Instead of modeling in clay built up on a supporting framework, necessitating reproduction of the model in a mold in which the final statue is cast, Miss Church builds up her framework of wire mesh, rods and heavy wire and applies the cement or plaster mixture directly on this, modeling it in place. While modeling directly in a Portland cement mixture is not entirely new, as this magazine has illustrated some of the work at various times and for several years back, Miss Church claims to have worked out some new methods for handling the mixture which facilitate work of this kind. On very large work the modeling is done in sections and the pieces afterwards assembled. This is important when a statue has to be shipped a considerable distance. Miss Church says she has overcome the difficulty usually attending upon making changes in work modeled in concrete and applying a new fresh mixture to an old mixture already hardened.

Large Cavity in Willow Tree Filled with Concrete

Tree Dentristry

The accompanying illustration shows a job of tree surgery or tree dentistry done at Grosse Pointe Farms, Detroit, Mich., by the Walker Tree Expert Co., Detroit. The cavity in this large willow was 6′ high and nearly 3′ wide at the widest part. A man could easily stand inside the trunk and it required 2,700 lbs. of mortar to fill the cavity.

Effects of Oil on Concrete

In reference to the effects of lubricating oils on machinery foundations of concrete, discussed by Leonard C. Wason and William M. Kinney, p. 211 of the Dec., 1915, issue of Concrete and referring to the effects of oils on concrete in general, attention is called to a pamphlet entitled, "The Effects of Oils on Concrete," published by the Security Cement & Lime Co.,[1] an abstract of current technical literature published in the interests of cement users, made by Arthur C. Hewitt, engr. for the company.

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[6] Canada Cement Co., Ltd., Montreal, P. Q.

[7] Bird & Son, Hamilton, Ont.

[1] Hagerstown, Md.

Three Dams of Power Project Involve Interesting Design and Construction

By E. Lauchli[1]

The three structures described in this article are part of the 100,000-h.p. Tullulah Falls development for the Georgia Railway & Power Co., at Tallulah Falls, Ga. They involve three radically different engineering problems, including a 100-ft gravity section concrete dam, a 90-ft. main storage dam, 630′ long, of the slab and buttress type, and a reinforced concrete cut-off dam, which, on account of the soil conditions, involves unusual foundation treatment.

INTAKE DAM

This structure, of gravity section, serves the double duty of adding 100′ to the natural head of 500′ and of raising the water to the 12-ft. by 14-ft. tunnel through the solid rock, 6,665′ to a forebay or surge reservoir, at the head of the penstocks. It also forms a storage basin 1½ mi. long. The drainage area above the dam is 192 sq. mi., most of which is well timbered and with steep slopes. The annual rain fall varies from 70″ to 80″. During construction the river flow has varied from 200 sec.-ft. to 15,000 sec.-ft.

Before making any decision as to the type of structure, due consideration was given, (1) to a concrete dam of the arch type; (2) a reinforced concrete buttressed dam; (3) a gravity masonry dam. Uncertainty as to the behavior of the strata at the upper part of the dam, when subjected to horizontal thrust, eliminated the first type, and the unusually favorable location of a quarry, eliminating costly transportation and handling charges, together with the good foundations available for a gravity dam, showed the cost of a reinforced concrete buttressed dam, even without downstream apron, to be greater than the gravity section.

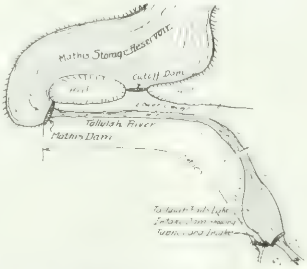

Fig. 1—Sketch Showing the Relative Locations of the Dams Described

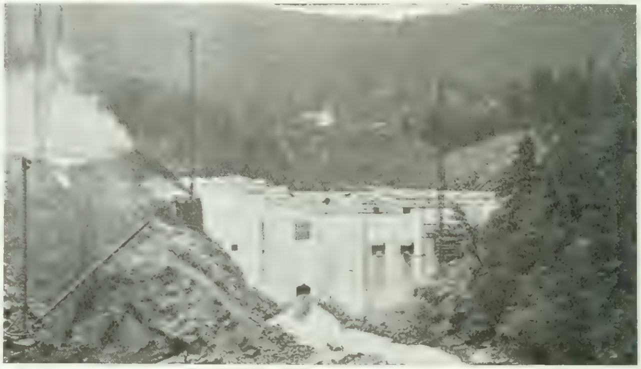

Fig. 2—The Intake Dam, Showing Quarry and Location of Derricks

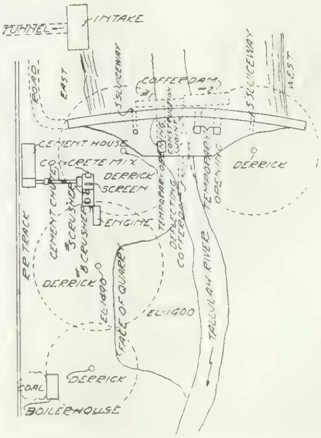

Fig. 3—Diagram of Plant Layout at Intake Dam

The design selected is illustrated by Fig. 4. The dam carries a highway bridge with a 12-ft. roadway, made up of plate girders, embedded in concrete, designed to carry, in addition to the dead load, a live load of 100 lbs. per sq. ft., and the reinforced concrete floor is designed for a concentrated wheel load of 8 tons. The spillway and the two 5-ft. sluiceways have a total discharge capacity of 20,000 sec.-ft. The crest is equipped with automatic flashboards 28′ long and 6′ high, hinged at the dam's crest. Each flashboard is provided with a heavy cylindrical reinforced concrete counterweight located above water and rolling on a curved track at the bridge pier (Figs. 4 and 5).

The dam is designed as a gravity structure, its curve to a 900-ft. rad. being disregarded entirely in all calculations of stability. No provision is made for upward hydrostatic pressure, but, to offset this possibility, the weights of the bridge, piers, flashboards and counterweights are not taken into account in the consideration of the stability of the structure against overturning, sliding or shearing. With the reservoir at maximum elevation, there is no tension in the upstream side of the dam, and the maximum compression at the toe does not exceed 12 tons per sq. ft.

FORMS AND CONCRETE

The curvature of the dam was made such as to avoid the use of curved wooden forms during construction, and offsets of 6″ were provided every 10′ at the upstream side to provide a seat for the forms, which were 4′ wide, 12′ long, and made up of 4-in. x 6-in. studs and 2-in. x 10-in. lagging. The forms were held in place by ⅝-in. round rods hooked up in holes drilled in the "plums." The specifications called for "plums" or stones as large as could be handled by derricks, to be embedded in 1:3:5 concrete, the plums to be spaced not less than 6″ apart, and be kept 12″ from any face of the structure. The percentage of plums is to be at least 30% of the mass. During construction, estimates showed that in the lower part of the dam this percentage was about 36, and the average of the entire structure 34%. Before being laid, the plums were thoroughly cleaned of earth and loose materials and washed; they were then laid over a bed of about 12″ of very wet concrete. Concrete was then poured and well spaded around and between the plums and brought to within 1′ of their tops, so as to provide adequate keying for the next layer of masonry. Before laying new concrete, the concrete laid previously was picked and washed under a water jet.

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[1] Civ. and Hyd. Engr., N. Y. C.

As shown at Fig. 2 a quarry site was available 200′ downstream from the dam, necessitating no transportation except handling with derricks. No sand being available, crusher product was used, screened so as to reject all particles over 1/4″ diam. Royal Portland[2] cement was sold the sub-contractor by the general contractor, at the railroad siding at $1.80, less 10 cts. for sacks. He was also furnished free of cost 1,000 cu. ft. of air per min. at 100 lbs. pressure, as well as electric current for lighting purposes. The following quantities of materials were involved in the construction of the dam: excavation, 10,600 cu. yds.; Cyclopean masonry, 39,200 cu. yds. The contract price for excavation, including stripping, earth excavation, rock excavation, wet or dry, was $1.50 per cu. yd. The contract price for Cyclopean masonry, concrete in the bridge piers and abutments, was $4.80 per cu. yd. The setting of gates and steel girders, and the reinforced concrete was paid for separately as extra work.

CONSTRUCTION PLANT

The construction plant was laid out as shown in Fig. 3, and consisted of the following equipment:

1 200-h. p. Hardie Tynes Corliss engine, 1 150-h. p. and 2 80-h. p. boilers, 1 Allis-Chalmers No. 8 gyratory crusher,[3] 1 Allis-Chalmers No. 5 gyratory crusher,[3] 1 set of 14-in. x 36-in. sand rolls, 3 steel derricks,[4] 115-ft. mast, 100-ft. boom, 15-ton cap., 30-h. p. steam engine; 1 wooden derrick, 65-ft. mast, 70-ft. boom, 18-h. p. engine; 18 7-ft. x 2-ft. x 9-ft. steel skips, 3 2-cu. yd. concrete buckets, 1 2-cu. yd. Austin cube mixer,[5] 1 Duplex steam pump.

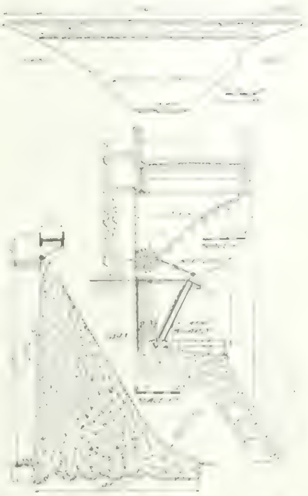

Fig. 4—Elevation Section, Also Detail of Flashboards and Highway Bridge

CONSTRUCTION

Excavation at the bottom of the east half of the dam was started in Aug., 1911, cofferdam No. 1 (Fig. 3) having been previously built for the purpose of diverting the river to the west half of the channel. The excavation in the east half averaged 5′ in depth, the maximum being 10′ below the original river bed. Solid rock of extremely hard character was encountered throughout, thus involving little trouble in securing adequate and very secure foundations. The first concrete was laid in Oct., 1911, and the east half of the dam was carried up about 40′ above the foundations. Cofferdam No. 2 was then thrown across the west half of the channel, one end being supported by the finished section, the other by the side of the gorge. The river was then diverted through an opening or tunnel 9′ x 10′ in the east half of the then completed part of the dam. A deflection cofferdam was built downstream parallel to the channel, to prevent water from filling the excavation at the west side, the foundation excavation being carried some 20′ below the river bed. Concrete was laid on this side of the structure beginning Feb., 1912. In March, a flood of 12,000 sec.-ft. took place, and the opening in the east half of the dam being inadequate to handle the river, water rose, passing over cofferdam No. 2, then about 30′ high, taking away some of the forms at the toe of the west half and about 250 cu. yds. of new masonry. Little damage was done otherwise and work proceeded without serious accident or delay.

From elevation 1,475 to the crest, the structure was carried up throughout at the same level. To prevent cracks from developing at the crest, 12 lines of steel rails were laid longitudinally, 6″ from the face and 4′ o. c. over and along the crest and down 20′ on the sides of the structure.

The lower opening was closed by dropping a heavy timber bulkhead in front of the opening, and a 4-in. drain pipe was provided at the bottom of the tunnel, thus enabling it to be filled with concrete without annoyance from leakage of the bulkhead. A pocket left above the opening enabled the voids left at the top of the tunnel to be grouted under pressure. Pending completion of the dam, water was then diverted through two 9-ft. x 10-ft. openings 40′ above the first opening. These proved very serviceable, when, in Mar., 1913, a flood of 15,000 sec.-ft. (largest flood recorded) caused the pond level to rise to elevation 1,459, i. e., to within 2′ of he sills of the intake gates, at a time when both intake and tunnel were still under construction. These openings were finally closed in a manner similar to that used in closing the lower opening. Aug. 11 the two 5-ft. sluice gates were closed, and water reached the dam crest on the next day.

During construction, the force at the quarry consisted of 50 men and 2 foremen, while at the dam a foreman and 10 men were at the mixer. Placing of Cyclopean masonry necessitated a foreman, 3 derrick men and 6 concrete men. After the standard wooden forms had been made so as to be used over and over again, placing and removing of forms required a force of 9 carpenters. Four men worked in the blacksmith and machine shops, and there was one timekeeper and one superintendent. Ten hrs. were worked each day, except Sunday.

Two derricks handled the rock from the quarry to the crusher, and two derricks placed the Cyclopean masonry and handled the forms. The rock was quarried at a cost of about $1.00 per cu. yd. About 1,000 cu. yds. of masonry were laid per wk. During construction, the temperature at the dam site varied from 10° F. to 120° F., yet only one temperature crack developed, which was in the third bay at the east end of the dam, extending about 20′ down from the crest.

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[2] Dixie Portland Cement Co., Chattanooga, Tenn.

[3] Allis-Chalmers Co., Milwaukee

[4] Am. Hoist and Derrick Co., St. Paul

[5] Municipal Engrg. and Contg. Co., Chicago

Immediately after water had reached the crest, and at a time when the masonry had not yet taken the temperature of the water, the horizontal downstream displacement of the arch crown due to the thrust, at the crest, was measured and found to be 1/8″. Measurements taken 2 mos. later, when the structure had cooled, showed a deflection of 1/4″.

Two structures were built in connection with the Tallulah Falls Development storage reservoir, which has a total capacity of 1,335,000 cu. ft. It is 9 mi. long, and was formed by throwing a reinforced concrete buttressed dam 650′ long and 90′ high across the Tallulah River, near Lakemont, Ga., 6 mi. above the intake dam just described, and by closing a gap or depression by a cut-off dam. (See Fig. 1.)

The cut-off dam of reinforced concrete (Fig. 6) is 330′ long between core walls and is 45′ high above the original surface of the ground. A feature is the deep cut-off wall, and the fact that about half the concrete yardage is below ground surface.

DESIGN

Several kinds of structures were considered to close this gap: an earth dike with reinforced concrete core walls; abandoned for the reason that the material suitable for an earth dam was not available. A masonry dam of the gravity type was out of question, owing to lack of adequate foundations. The design for a reinforced concrete structure was then prepared, with a cut-off wall 10′ to 15′ deep, and buttresses resting on spread footings. While this design was being elaborated, test pits sunk at various points of the proposed cut-off wall revealed the facts that rock was not available except at great depth, and that the material penetrated was chiefly sand mixed with a little clay. The design of the dam as constructed employs buttresses spaced 18′ o. c., and instead of spreading the footings, a continuous mattress, heavily reinforced with steel bars[6] was provided, its duty being (1) to reduce the pressure on the sub-soil; (2) to avoid unequal settlement; (3) to prevent the buttresses on the side slopes from moving sideways; (4) to increase the stability of the structure against sliding, due to water pressure acting on the deck (Fig. 7).

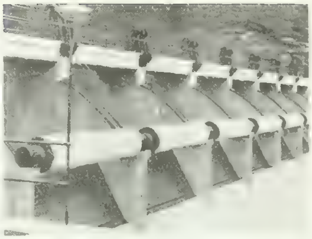

Fig. 5 Automatic Flashboards with Reinforced Concrete Counterweights

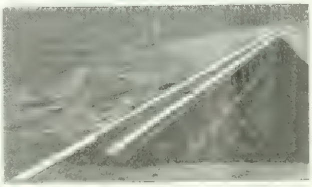

Fig. 6 The Cut-off Dam

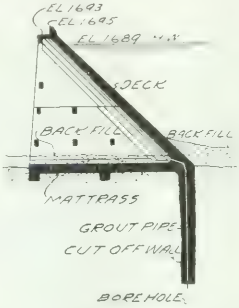

Fig. 7 Section of Cut-off Dam and Wall

The pressure on the foundation is uniform with reservoir empty; with water at elevation 1,692 (a provision of 3′ above normal being made for wave action), the pressure at the heel and the toe of the dam is 920 lbs. and 1,370 lbs. per sq. ft., respectively. The friction coefficient against sliding is .47. In order to increase further the stability of the structure against sliding, two longitudinal reinforced concrete ribs were provided at the toe and at the center of the lower side of the mattress. The latter rib is reinforced with 1-in. steel bars placed so as to take care of positive and negative moments, and near the buttresses the depth of the mattress is increased to take care of shearing stresses. Care was exercised in making provision that would exclude the possibility of water finding access under the mattress and to effect this the cut-off wall was carried deep into the ground and the junction point of the mattress with the cut-off wall and the deck was provided with ample reinforcement. However, as the structure is not designed to resist upward hydrostatic pressure, and in order to provide for unforeseen contingencies, weep holes have been provided through the mattress.

CONSTRUCTION

Buttresses are made of 1:3:6 concrete; the specifications allowed 300 lbs. per sq. in. for concrete in compression and 100 lbs. for shear. From the mattress up to elevation 1,670, the buttresses are 16″ thick and above that elevation 14″. Though a thickness of 10″ would have been ample at the top to resist the stress, it was found advisable to increase the thickness so as to provide ample room to place the steel and to spade the concrete. At cross-strut points, the buttresses are reinforced with vertical and with horizontal rods. When pouring one of the last buttresses, a mixture of 1:2:4 concrete was used and it was found that economy in labor would result by using a rich mixture for work of this kind, as much spading and finishing could thereby be avoided.

Decks are 1:2:4 concrete, unit stresses of 600 lbs., 60 lbs. and 14,000 lbs. per sq. in. being allowed for concrete in compression and shear and for tension in steel, respectively. Reinforced concrete structures of this type are of relatively recent design; few data are available as to the behavior of steel reinforcement embedded in thin concrete slabs subjected to hydrostatic pressure. It was therefore decided to curve the lower side of the deck, making an arch able to resist the full hydrostatic pressure, in case of failure of the steel reinforcement, from corrosion. The decks are free to expand or contract horizontally, and strips of hair felt are provided between the deck and the haunches so as to insure watertightness.

At each end of the structure, concrete cut-off walls 20′ to 30′ deep were carried into the side hills to exclude the possibility of leaks or washout around the structure.

Struts between the buttresses are 12″ x 24″ in cross section, reinforced with 5 1-in. corrugated bars, lapped 36″ at the ends, so that no special provision is made for temperature stresses, except that ample reinforcement is thus provided.

The cut-off wall is 3′ 6″ thick and 30′ x 50′ deep. The material encountered during excavation was such that little reliance could be laid upon it as a barrier against water under pressure, and an endeavor was made to carry the cut-off wall down to solid rock. A wooden derrick with a 60 ft. boom and a steel derrick with a 100 ft. boom handled the material excavated from the cut-off trench. Excavation was done with picks and shovels, no blasting being required. After rock had been reached, drills were put to work in order to ascertain the nature of the underlying strata. Except in a few instances, soft solid rock was encountered, which disintegrated rapidly upon being exposed. It was then decided to provide all test holes with grout pipes, extending these clear up to the ground surface, on the down stream side of the deck, and to grout these under pressure, should leaks develop with the reservoir full.

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[6] Corrugated Bar Co., Buffalo

The cut-off wall was concreted in sections, between wooden bulkheads, the abutting surfaces of the sections being tongued and grooved. A 1:3:6 concrete mixture was used, one-man-size stones being embedded in it. During construction, the question arose as to the possibility for vertical temperature cracks to develop in the cut-off wall, which might let water seep under the mattress. The writer carried on a series of observations for the purpose of ascertaining the variations between ground and air temperature, at and in the vicinity of the structure, in bore holes 2.5′ to 45′ deep.

Ground temperature recorded at the bottom of the 45-ft. hole was found to be constant throughout the year, and 2.5° F. higher than the average yearly air temperature at this site (59° F.). The temperature recorded in a bore hole 16′ deep showed a greater variation between air and ground temperatures. It was anticipated that the upper part of the cut-off wall would be subjected to at least or nearly the same temperature variations as water in the reservoir, that is from about 34° F. to 75° F. and therefore the upper 15′ to 20′ of the cut-off wall were reinforced with ⅝-in. vertical rods spaced 2′ o. c., and with 1-in. horizontal rods spaced 12″ o. c. At a depth of 2′ to 3′, the ground is subjected to daily temperature variations; therefore the concrete mattress, in addition to its heavy steel reinforcement, was covered with 3′ of earth, so as to minimize the effect of temperature changes.

The decks, which of course are well exposed to temperature variations, are free to expand horizontally. In certain instances, with the reservoir empty, the joints opened from 1/16″ to 1/8″ per panel.

The concreting plant consisted of a ½-yd. cube mixer, located about 30′ back of the cut-off wall, at the center of the structure, and the concrete was handled with derricks from the mixer to the forms, into especially designed buckets resting on a car rolling back and forth on a track laid on the top of the buttresses.

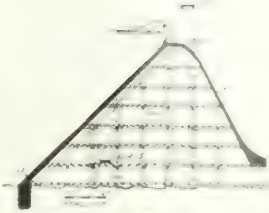
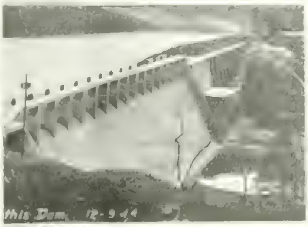


Fig. 8. Section of Mathis Storage Dam



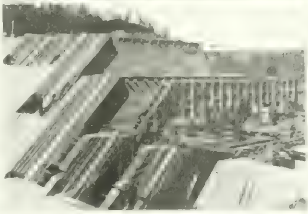


Fig. 9. The Mathis Storage Dam

Fig. 10. Construction of Mathis Dam

About 180 cu. yds. of concrete were laid per wk., the maximum being 478 yds. The whole structure involved 4,523 cu. yds. of concrete and 288,830 lbs. of reinforcing steel, that is, 64 lbs. of steel per cu. yd. of concrete. An average of 12,600 lbs. of reinforcing steel were laid per wk. and a minimum of 26,000 lbs.

MAIN STORAGE DAM

The main storage dam consists of a spillway section 288′ long (Figs. 8 and 9), flanked at one end by a bulkhead section about 50′ long, and at the other by a power house. The total length of the dam is 630′ and the height of the spillway section, from base to crest, is 90′. In the spillway and bulkhead sections the buttresses are spaced 18′ o. c. and in the power house section 20′.

Decks are arched and free to expand or contract horizontally. Their thickness varies from 39″ at the base down to 18″ at the top. The apron, on the downstream side of the structure, is 18″ thick; both deck and apron are reinforced horizontally with corrugated bars 1″ to 1⅛″ diam., spaced according to the hydrostatic pressure, the spacing varying from 4″ to 7″. Distributing rods ⅝″ in diam. are also provided longitudinally 24″ apart. In order to obtain a waterproof joint between the deck and the buttress, 3/16-in. x 6-in. hair felt strips laid in asphalt have been provided, and the buttress tongues are provided with recesses, as shown in Fig. 10. The spillway buttresses, reinforced horizontally and vertically with 1-in. corrugated bars, were built in 12-ft. lifts, each lift having a different thickness according to its height above ground. They also taper from the upstream end to the downstream end; for instance, the lower lift tapers from 40″ to 32″. The upper or top lift is 26″ thick, this thickness corresponding to the thickness of the bridge piers on top of the spillway, and carries a foot bridge. The spillway buttresses have a total width at the base of 148.5′, thus offering ample leverage against overturning forces.

The cross-struts, between buttresses, are 18″ x 24″ in section, and reinforced with 5 1-in. corrugated bars, overlapping at buttress points, except over every third buttress, where the rods butt in order to allow for contraction of the struts. Struts are spaced 15″ and 12′ o. c. in a horizontal and a vertical plan, respectively.

At elevation 1,609.75 a reinforced concrete walkway 6′ wide is provided for inspection purposes, and to give access to two 48-in. gate valves located at the base of the structure, in the center of the spillway section. A walkway has also been provided at elevation 1,655 for inspection purposes, and to give access to a gate valve located at the east end of the structure, at elevation 1,643.

Bulkhead buttresses are of simple design, their thickness being uniform for the same lift; it varies from 31″ for the bottom lift to 16″ for the top lift. These buttresses were also built in 12-ft. lifts, and reinforced horizontally at lift elevation, and vertically at cross-strut point. The top lift has a vertical downstream face, the other lifts having a battered face. The power house section consists of heavy buttresses spaced 20′ o. c., with two intakes feeding the 12-ft. penstocks of the two 3,000-kw. units installed in the power house. The latter is a brick structure, with steel frame and concrete roof, 40′ x 65′ in plan. The roof slabs are carried on I-beams and steel channel purlins. The slabs are 4″ thick and reinforced with Hy-Rib[7] material.

The dam involves 23,700 cu. yds. of excavation, 33,600 cu. yds. of concrete and 1,908,000 lbs. of steel reinforcement, that is, about 60 lbs. of steel per cu. yd. of concrete.

The following unit stresses were allowed in designing the various parts of the structure: Compression in buttresses, 300 lbs. per sq. in.; shear in butts. 100 lbs. Compression in decks, aprons, beams and bridges, 600 lbs. per sq. in. and 60 lbs. for shear. Tension in reinforcing steel, 14,000 lbs. All decks, aprons and beams were made of 1:2:4 concrete, and the buttresses of 1:3:6 concrete.

Wooden forms were used throughout the dam for concreting purposes and standard forms were built for the buttresses, decks, aprons and cross-struts, and used over and over again. The buttress forms were held together with iron bolts passed through card board tubes dipped in paraffin, thus enabling the bolts to be pulled out easily when stripping the forms.

The concrete plant was located about 300′ downstream of the dam and the concrete buckets were conveying to the dam on cars pushed by a dinkey locomotive, and then carried over the structure by Lidgerwood cableways[8] of 800-ft. span. The cableways were of great assistance in erecting and stripping the forms.

This dam, like the intake dam, is equipped with automatic flashboards provided with reinforced concrete counterweights. These structures were built by the Northern Contg. Co. for the Ga. Ry. and Power Co., for whom Charles O. Lenz is chf. engr. The Hardaway Co., Columbus, Ga., was sub-contractor; Chas. G. Adsit, engr. in chg. of const., and H. T. Hartwell resident engr. The late John Birkenbine was consult. engr., being represented in the field by his son, Henri Birkenbine. The writer was in charge of the design and supervised the construction.

Conduits and pipes can be kept the proper distance from forms by stringing ordinary iron washers on them at intervals.

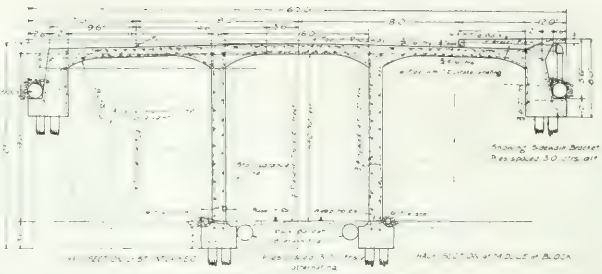


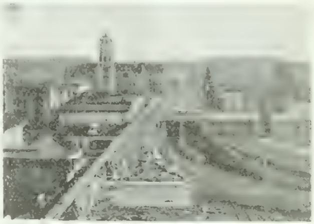
Fig. 1 Typical Section of Subway

Distributing Concrete on Subway Work

By H. L. Quigley[1]

The construction of the Olympia St. subway at Seattle, Wn., presented some unusual difficulties owing to the fact that steam traffic had to be maintained in the excavation at all times and owing to the location of the aggregate as received by water.

The structure was designed by the bridge department of the Northern Pacific Ry. for a live load of 100 lbs. per sq. ft. on the sidewalks and 150 lbs. per sq. ft. on the roadway with specified unit stresses and to be carried within safe limits for an 18-ton roal roller. The street crossings are designed for double street car loading of 34-ton units. The subway proper is a 1,000-ft. section of a 60-ft. roadway. It was constructed in wet clay and rests on approximately 1,300 piles with an average penetration of 38′, designed for an 18-ton stress per pile. The reinforced concrete was placed as per typical section in Fig. 1. All concrete was proportioned by volume, the mix in the subway proper being 1:2:4, (rock ranging from 1/4″ to 1″), retaining walls 1:3:5 (rock ranging from 1/4″ to 2 1/2″) and sidewalks finished in 1:3. The sand was clean, coarse and sharp, ranging from 1/4″ down. Care was taken to place no reinforcing steel less than 2″ from any face of the concrete. The backs of all retaining walls and sidewalks of the subway as well as the entire top of the structure were given three heavy coats of asphaltum. The embankments at either portal were shaped to 1 1/2:1 slope from base to street level.



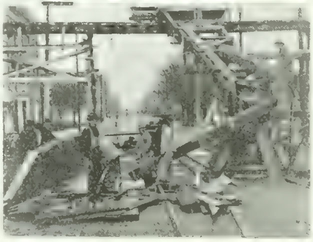


Fig. 2 General View of Subway and Trestle for Conveying Concrete

Fig. 3—Detail Showing Trestle, Receiving Bin and Spouting Equipment

A mixing plant was erected on the water front where scows brought the sand and gravel and a clam shell bucket elevated the materials to a storage bin. From a gravity-fed batch mixer, the concrete was carried in a 1-yd. concrete car hauled by a cable over a long temporary track. About 700′ of the track from the west portal was a 5% grade as shown in Fig. 2. The track from portal to portal was down grade.

The trestle was built on bents, of two 6 x 6 uprights braced by 1 x 6s. The cross member was a 10 x 10 and 4 x 6 ties rested upon two spiked 4 x 12s on the cross members. The side bracing shows in the construction views.

The car emptied the concrete into a wooden receiving bin from which it was spouted to the forms through a wooden chute. The bin and spout as used on the walls was rigged as a solid unit and was moved along the work on a track as shown in Fig. 3. One part of the track for this spout is the third rail on the trestle and the other on an individual trestle next to the south property wall.

The contract was executed by the Pearson Construction Co., Seattle, under the direct supervision of W. C. Taylor. The approximate quantities used were—8,000 cu. yds. of concrete, 60.500 lbs. of reinforcing steel, 22,600 sq. ft. of sidewalk protected by 1,150 lin. ft. of three-line 1 1/2-in. gas pipe railing.

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[7] Trussed Concrete Steel Co., Youngstown, Ohio

[8] Lidgerwood Mfg. Co., N. Y. C.

[1] Seattle, Wn.

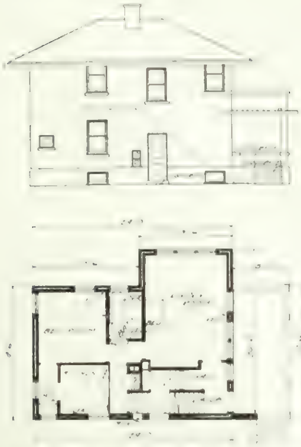

Fig. 1. Plan and Side of Band Box Apartment

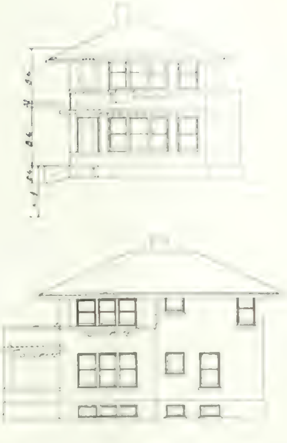

Fig. 2. Front and Side Elevations

A "Band Box," Two Family Apartment, To Be Built of Concrete

By Glen M. Rees[1]

A two-family house of low cost and possessing a number of unique design and construction features is to be built in early spring at Rochester, N. Y. The designer has not only specialized in heavy concrete construction but has also spent much time in an effort to build true concrete houses of good design and at low cost.

In this effort he has been unusually successful and this magazine hopes to present occasional examples of his work.

Designed to meet the demands of economy in space and expenditure, the construction and arrangement of this unique low-cost apartments holds place in the hot pace set by concrete designers and students of hygiene and modern living. The building is extremely economical as to maintenance, being constructed with concrete walls, floors and roof and metal window sash and frames.

While a number of construction methods are available for working out these plans in concrete that selected is the so-called thermos bottle construction erected by means of a hollow wall machine.[2] This construction is, in reality, one house within another, with an air space of 2½″ between the walls, each wall being 4″ thick. This construction makes a dead air space except for vents, and has proved its value in reducing the winter coal bill, as compared with wood frame.

DESIGN AND CONSTRUCTION

The arrangement is very compact, being laid out on the lines of a city apartment, but is more desirable on account of the great amount of light possible. Three rooms and a bath are provided; a good sized living room with bay window, a kitchenette with small cooking closet combined with dish cupboards, ice box, range, etc. The kitchenette is separated from the stairs by a folding screen on rubber rollers so that the whole space can be opened up for a dining room in the event of the adjoining rear room being used as a bed room, which is not necessary when there are but two in the family, as it is arranged to have a sanitary and ventilated bed slide under the raised floor of the bath room.

The end of the iron bed which projects in the living room is finished as a couch or other piece of furniture to suit requirements. The bed, when rolled in, has a galvanized iron case, making it dust proof and air tight from the room. The case is connected at the bottom with a fresh air stack and at the top with a vent stack, which provides a free and positive circulation of fresh air over the bed at all times. Each room has a vent stack in the hollow concrete wall, which discharges under the cornice; vents of baths and of kitchens are at ceiling and those of living room and of bed room at floor.

The apartments are heated by separate furnaces. Furnace heat is especially advantageous, as fresh air must be brought in through the fresh air ducts.

FLOORS AND ROOF

The floors are designed to carry a live load of 50 lbs. per sq. ft. and are 5½″ thick in large rooms. The small rooms do not require this thickness but are left the same in order to facilitate the form work and construction. The reinforcing in floors is to be expanded metal of about 2½-in. mesh and 3/32″ running in direction indicated. The concrete floor slabs are covered with 7/8-in. oak flooring on 2-in. x 2-in. wood sleepers. The roof is a 4-in. slab reinforced with rods and overlaid with expanded metal the same as floors. Over the slab is spread ordinary wire chicken netting, to be covered with ¾″ of very rich cement mortar, which is to be cut through with a marking tool to the netting in squares 2′ x 2′ or less, the joints to be filled with asphaltum or other elastic waterproof pitch. The roof surface will be troweled smooth and waterproofed with R. I. W.[3] The outside of building will be stuccoed and painted with two coats of waterproof cement paint.

COST

Contract prices received by the builder, H. E. Kondolf, are given in itemized form and indicate a cost of $5.50 per sq. ft. of area on the ground. It will be noted that few flats constructed with one family above the other can be built entirely of wood for this price.

Estimated Cost of Band Box Apartment

112 yds. sand and gravel @ $1.25	$ 150.00
182 bbls. cement @ $2, less $54 for sacks	310.00
5 tons of plaster @ $7.50 per ton	27.50
Wire mesh and reinforcing steel	103.03
1,000 brick	20.00
Mason labor	312.00
Flashing and tin work	15.00
Floors and sleepers	110.00
Heating system—two furnaces	190.00
Plumbing complete	365.00
Electric wiring	125.00
Painting and finishing	140.00
Interior trim and mill work	147.00
Carpenter work	186.00
Metal frames, sash and glass	763.00
The substitution of wood frames, doors and sash would save $400.00 on this item	
Light fixtures	60.00
Hardware	10.00
And adding for incidentals	100.00
	$3,473.53

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Concrete Aggregates: Second Article—Tests and Test Methods—Sampling

By William M. Kinney[1] and Duff A. Abrams[2]

This is the second of a series of articles, most important to the entire field of concrete work, on Aggregates. *The first article taking up the classification, sources, physical conditions and general requirements of aggregates, appeared in the December, 1915, issue. The third article in the series will be published in the April, 1916, issue and will be a further discussion of Tests of Concrete Aggregates and the Significance of these Tests—based upon some of the very latest research.*

TESTS OF CONCRETE AGGREGATES

The purpose of making tests of structural materials is to determine in advance of use whether or not a given material fulfills the requirements of the service demanded. For many of the older structural materials, many years' experience and tests have shown with a fair degree of accuracy what requirements must be met in order that they may be expected to give satisfactory results in service.

Experience has shown that the durability of the material; grading, with reference to the maximum sizes and the relative proportions of finer materials; the shape of the particles or the form of fracture; the nature, amount and distribution of impurities are the most important elements in determining the suitability of a given material for use as a concrete aggregate. All tests of concrete aggregates are made with a view to classifying the materials with reference to one or more of these qualities. When it is considered that the materials used for this purpose include practically every form of inert solids which are found in nature or which result from manufacturing processes, it is readily seen that tests must be of the widest application. The following may be mentioned as indicating the range of materials used for this purpose: Natural sands and gravels, crushed rock of all kinds, crushed blast furnace slag, chats, broken brick, coke, coal, cinders, shells, etc. The tests which should be made and their interpretation must always depend upon the nature of the material and the purpose for which the concrete is to be used.

It is only within recent years that the necessity for testing concrete aggregates has been recognized and that any concerted effort has been made to formulate suitable test methods. The earlier users of concrete depended entirely upon a visual inspection and the general reputation of a material to determine whether or not it was satisfactory. Recent experience has shown, however, that careful inspection and tests of concrete aggregates will frequently serve to eliminate materials which are inferior, if not altogether unsuitable, and in most cases would amply repay the cost as a result of the better grade of concrete which is secured by using discretion in the selection of the best available material.

The following classification may be made of tests of concrete aggregates. The major divisions of the tests are given in the general order of their importance for the average conditions.

A. Durability of particles.
  (1) Resistance to weather, strength, hardness, toughness, brittleness, resistance to fire, etc.

B. Strength tests of mortar and concrete.
  (2) Tension tests of sand mortar.
  (3) Compression tests of sand mortar.
  (4) Compression tests of concrete.
  (5) Wear tests of mortar or concrete.

C. Cleanness tests.
  (6) Amount of impurities (silt determination).
  (7) Nature of impurities (chemical analysis).
  (8) Effect of washing on mortar strength of sand.

D. Grading (size and shape of particles).
  (9) Sieve analysis.
  (10) Density of mortar or concrete of a given mix.

E. Miscellaneous tests.
  (11) Determination of voids.
  (12) Specific gravity.
  (13) Weight per unit of volume.
  (14) Permeability of concrete or mortar of a given mix.
  (15) Microscopic examination.
  (16) Petrographic analysis.
  (17) Chemical analysis.

It must not be assumed that each of the tests mentioned under the headings A to E are expected to reveal different qualities of an aggregate material. On the contrary, the results of many of the tests are interdependent. There may be some difference of opinion as to the relative importance of the qualities mentioned. It is recognized that in a given region tests must be aimed at the detection of certain qualities which would be of no importance in other localities. For instance, a given territory may furnish an abundant supply of clean sand which is poorly graded for concrete work; while in another territory the sand may be well graded but contain objectionable impurities.

There is little question of the importance of the quality or durability of the aggreates used in a large amount of concrete work. Only in rare instances is any attempt made to determine relative durability, yet we unconsciously recognize its importance and reject materials which are manifestly unsuitable. On the other hand, the strength tests, if properly carried out and interpreted, yield information as to the ultimate effect of many other qualities of an aggregate.

Before entering into a detailed

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discussion of aggregate tests, it seems desirable to present a few remarks on field tests and sampling.

FIELD TESTS

Field tests of concrete aggregates are understood to include visual inspection and all determinations which can be made by means of the physical senses and such apparatus as may be found ready at hand or conveniently carried about. It is recognized that the value of visual inspection depends entirely upon the experience and training of the individual making such inspection. However, it is usually assumed that field tests are of a simple character and of such an approximate nature that they can be carried out and properly interpreted by men of little or no experience in the use and testing of such materials.

In attempting to form an opinion of the quality of an aggregate it should be borne in mind that nearly all materials in their natural state contain a large amount of moisture which gives an appearance to the material which is often entirely different from that after drying. High grade aggregates have been rejected simply because the inspector formed an erroneous opinion as to the fineness of the material or the amount of impurities, on account of the fact that the material was wet at the time of inspection.

The field tests which may be applied to advantage depend upon the nature, location and previous treatment of the material. A careful examination of the surroundings from which a material comes and an inspection of the operation of the plant producing it frequently furnish valuable guides.

Visual inspection and field tests are frequently relied upon to give information as to the probable durability of a material, its cleanness and grading. A sand which consists largely of soft particles, or is too fine, or contains a large percentage of impurities, may properly be rejected on the basis of visual inspection. The presence of too much dust in crushed stone or the prevalence of coarse material can easily be determined by visual inspection.

As an aid to field inspection, certain methods and apparatus are sometimes recommended. The following may be mentioned:

An approximate notion of the amount of clay or loam contained in sand can be obtained by rubbing the dry sand between the palms of the hands and noting the character of the discoloration. Another method consists of dropping a handful of sand into a basin of clean water and noting the resulting turbidity. A more exact determination of cleanness of sand may be made in the field by filling a cylindrical glass jar or bottle about half full of sand and adding sufficient water to cover the sand 2" or 3". Close the top of the vessel and shake vigorously for a few seconds; then set aside and allow the suspended material to settle on top of the sand. The length of time required for the water to become clear and the depth of the deposit on the surface of the sand should be noted. If a glass graduate is used for this purpose a quite accurate determination of the silt content of a sand can be obtained. It should be noted, however, that the results of this test cannot be compared directly with those obtained by the usual laboratory methods on the basis of the loss of weight. In the field test mentioned above, the silt is determined on the basis of volume; the results are also influenced by the effect of the buoyancy of the water on the silt. This test would show a higher silt content than most of the laboratory methods.

The grading of aggregates with reference to the amounts passing certain sieves can be roughly determined by means of a set of portable sieves. Certain engineering organizations have provided their field inspectors with outfits consisting of two or three sieves, a glass graduate, rule, etc., which in the hands of intelligent men may be expected to give fair indications of the cleanness and grading of aggregates.

In the case of coarse aggregates a visual inspection will reveal the presence of large amounts of clay, loam or soft pebbles in a shipment of gravel and will indicate whether or not it deviates largely from the proper grading. A fair guide as to the quality of a crushed stone may be obtained by examining the ledges which have been long exposed to the weather, by noting the form of fracture and shape of particles, and by breaking the particles in the hand or by cutting with a knife. A stone which has disintegrated from exposure to the weather for a few years, or which can be easily broken between the fingers or readily cut with a knife probably will be undesirable for concrete which is to be subjected to severe stresses or exposed to the action of the weather, or used above ground in the presence of water. For such purposes as the wearing surface of roads and pavements, aggregates of good weathering qualities, which are hard and tough, must be used.

While the evidence of visual inspection and field tests should never be overlooked, it is generally recognized by progressive engineers that such tests are not sufficient for the purpose of discriminating among several lots of materials, all of which may be of a good grade. Field tests may serve to determine whether or not a material may be expected to comply with certain minimum requirements of a specification, but they give no reliable indication of the relative merits of different materials and may prove wholly misleading. Field tests such as those described above may reveal the presence of impurities, but they give no indication of the nature of such impurities or their effect on the setting and hardening of the cement and the final strength of the concrete.

These remarks apply with particular force to fine aggregates, and especially to natural sands. A few engineers have carried field tests to such an extent as to make up blocks of mortar or concrete from the materials available at the site of the work. By noting whether or not the concrete hardened satisfactorily, and by breaking with a hammer after a few days, or by loading to failure as a beam, they felt assured that no serious mistake was being made. This, however, is a recognition of the value of careful tests and amounts to conducting makeshift laboratory tests in the field.

Differences in the hardness of sands, silt content, grading and shape of the particles exert such an important influence on the strength, durability and water-tightness of concrete that they cannot properly be left to makeshift methods. Most concrete engineers are now agreed as to the importance of properly made laboratory tests for determining the relative value of aggregates for use in concrete for a given service.

SAMPLING

The most carefully conducted tests of concrete aggregates may give entirely misleading results unless extreme care is used in selecting the material which is to be used in the test. The best place to secure a representative sample is after delivery of the material on the work. In this case small lots should be taken from different portions of the pile and mixed together to form a test sample. However, it is a better policy to sample materials of this kind as close to their source as possible, in order to avoid unnecessary expense in handling lots which are later rejected.

Little difficulty is usually encountered in selecting test samples from crushed stone, if care is taken to see that the materials of different sizes have not become separated in loading or piling.

In sampling natural sands and gravels in the pit the greatest care must be used. Many sand and gravel pits contain material of such diverse characteristics that aggregates of the greatest variety may be obtained within a distance of a few feet; yet in the process of excavating, transporting, screening, washing, etc., the materials are so thoroughly mixed that uniform, high grade sand and gravel are produced. Test samples of a material of this kind should be taken from the storage bin, or from material already loaded for shipment.

It is in sampling a deposit which has not been developed that the greatest care is necessary. The method to be used will depend on the nature and extent of the deposit, the contour of the land, etc. Probably the most effective method is to sink wells at several points, then make detailed examinations of the materials in the different strata. This method avoids the effect which may result from the contamination of the deposit by surface drainage, etc., which cannot easily be avoided if samples are taken from the face of the proposed pit. Face sampling can be done successfully only by excavating trenches to such a depth throughout the deposit that all surface soil is removed and rejected before taking out the materials for testing. The material thus excavated can be mixed and test samples taken, or detailed examinations can be made of the material taken at different depths.

The amount of materials necessary for a test sample will depend upon the number and kind of tests to be used; however, for the usual tests about 25 lbs. of fine aggregate should be submitted and not less than 50 lbs. of coarse aggregate.

Experience has shown the necessity for using the greatest care in sampling in the laboratory, since otherwise the results of the tests may be entirely misleading. The method of quartering is generally employed. To quarter a sample of aggregate, spread the material on a clean floor or table. The pile should be nearly circular in outline and of uniform thickness, care being taken to distribute the material as it is poured out. Divide the pile into four equal parts; remove two opposite quarters, using care that all fine material is taken. The remaining quarters are then mixed and the process continued until a sample of the proper size is obtained. This method is laborious and time-consuming. Much better results can be obtained by the use of a sampler or riffle, which can be supplied by the scientific apparatus dealers. This apparatus, by halving or forming other fractional divisions of the material, very quickly enables the operator to secure a representative sample of any desired size. This apparatus is widely used in mining operations and in assay laboratories.

LABORATORY TESTS

Due to the fact that the importance of aggregate tests has become only recently recognized, there does not exist at the present time a well recognized procedure in carrying out such tests. From the nature of the materials encountered it is apparent that it is a most complex problem when one attempts to determine the effect of each variable which may enter into the quality of an aggregate (strength, hardness, brittleness, cleanness, grading, petrographic composition, chemical analysis, etc.), on the final strength and durability of concrete made from it.

At the present time it is impossible to foretell the effect of all of these variables, or to fix the exact influence of any of them. However, long experience has shown that certain tests are of the utmost value in furnishing a criterion of the concrete-making qualities of aggregate materials.

It may be repeated that the subject of the testing of concrete aggregates is receiving more attention at the present time than ever before. It is probably true that this class of materials is now the subject of a greater number of investigations than any other single group of engineering materials. Nearly all of the more important engineering societies which have to do with structural work are carrying out studies with a view to arriving at more rational specifications and methods of tests for concrete aggregates.

While it is not assumed that it is necessary to make laboratory tests on each lot of aggregate material used, the authors desire to give the utmost emphasis to the value of tests in indicating the value of a new or untried material before it is used in an important structure. Materials which are known to be of a high grade may generally be accepted for all ordinary purposes. For important pieces of work special studies of materials, proportions, etc., should always be made.

Laboratory tests will be discussed in accordance with the outline given above.

A. DURABILITY OF PARTICLES

Under the heading of durability we have grouped a number of the fundamental physical properties of concrete aggregates. The following may be mentioned: Strength (the ability to withstand stresses of any kind due to load); hardness (the ability to resist penetration); toughness (the ability to withstand a repetition of impact or other similar stresses); brittleness (the ability to withstand distortion); resistance to fire, weathering, etc. These properties are largely interdependent and

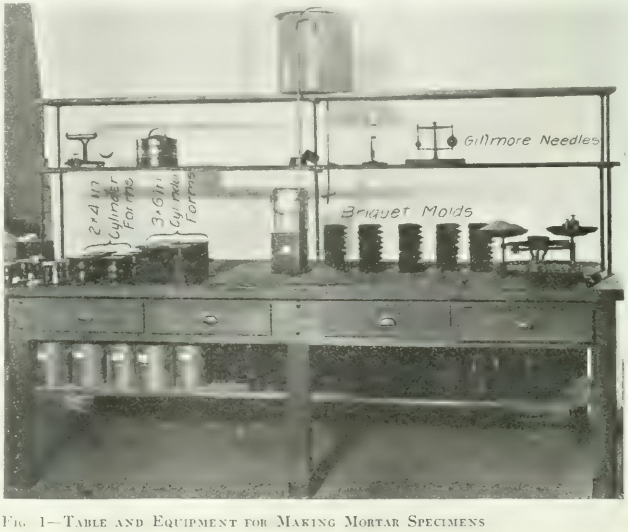

FIG. 1—TABLE AND EQUIPMENT FOR MAKING MORTAR SPECIMENS

are such as are recognized in all materials.

It is not customary to make tests on concrete aggregates with a view to determining the effect of each of these properties, yet we unconsciously weigh and pass upon all such factors in arriving at a conclusion as to the suitability of a given aggregate for any service. Compression tests of 2-in. cubes are frequently made in order to determine the quality of a stone for building purposes. Tests of this kind are difficult and expensive to make and cannot be applied to many classes of aggregate materials. The results of such tests are of doubtful value. A direct test of strength of an aggregate material is not important, since the ultimate value of the material in concrete generally depends on other factors.

Certain tests for determining the toughness, hardness, abrasive resistance, etc., of crushed rocks have been used. These tests were standardized in this country by the U. S. Office of Public Roads. They have heretofore been carried out with particular reference to determining the suitability of a rock for use in macadam road construction. It is not clear now just what relation the evidences of these tests has to the suitability of a crushed rock for use as a concrete aggregate. The tests which have been standardized by the office of Public Roads, cannot readily be applied to gravels or sands. There is great need for tests which will serve to discriminate between aggregate materials which are too soft, or too brittle, for use, and those which may be expected to give good results.

Little attention has been given to determining the weathering resistance of aggregates. Many studies have been made in this country and in Europe for the purpose of determining the weathering resistance of building stone. A laboratory test which will furnish an infallible guide to the weathering resistance of stones under different climatic conditions has not been discovered, although many such tests have been proposed and used. Alternate freezing and thawing, acids or some disrupting agency represent the most commonly used tests for this purpose. Except for certain classes of concrete construction the weathering resistance of aggregate materials is not of supreme importance, providing we are assured that the material will not be decidedly affected by weather. However, for use in the wearing surface of roads and pavements, in river and harbor structures, etc., it is important that the aggregate possess a high degree of resistance to weathering.

A high degree of resistance to fire is an important property of an aggregate which is to be used in biulding construction and is a desirable quality for all aggregates. It is a matter of common experience that material of very low fire resistance frequently gives a good account of itself when used as a concrete aggregate. Coke breeze and coal are frequently used as aggregate materials. In this condition the materials are affected only after the application of a high degree of heat for a considerable period of time.

Further experimental studies should be made of the fire resistance of concretes made from different aggregates.

B. STRENGTH TESTS OF MORTAR AND CONCRETE

A discussion of tests of concrete aggregates must of necessity deal largely with tests of mortars and concretes, since it is in this form that the most direct indications of the quality of the material can be obtained.

A suitable strength test of a mortar or concrete made up from a good cement and the aggregates in question, is without doubt the most reliable single determination which can be made. This test gives information as to whether or not the aggregate affects the setting and hardening of the cement—a consideration of prime importance. It also indicates what may be expected from the standpoint of strength. If the form of test specimen, proportions, method of mixing, seasoning, etc., are standardized or are made to approximate those used in the work, an excellent notion can be secured of the probable strength of the concrete in the structure. It seems apparent that tests of concrete would furnish the best criterion of the concrete-making quality of either a fine or a coarse aggregate.

In the process of development of tests of concrete materials, the method of making strength tests of fine aggregates was adapted largely from the methods which have been in use for many years in tests of cements. The most reliable test of a cement which is now recognized as standard is that resulting from a test of cement mixed with three parts by weight of standard sand, the amount of water used and other details of the test being specified.

The foregoing, of course, refers to tension tests of briquettes. For the details of making and testing sand mortar briquettes, reference may be made to the Standard Specifications for Portland Cement of the Am. Soc. for Test. Mat., and the Report of Committee on Uniform Tests of Cement of the Am. Soc. of Civ. Engrs. These reports can generally be secured from the cement manufacturing companies. The equipment which is necessary for a cement testing laboratory will also serve for making briquette tests of fine aggregates.

A 1:3 mix of cement and sand has become standard largely for the reason that differences in the quality of the cement or sand are emphasized to a much greater extent by a comparatively lean mix of mortar than by a richer mix. For instance, the difference in the results of the strength test of a coarse, well graded concrete sand and a fine sand which is wholly unsuited for first-class concrete work is less in the case of a 1:2 mix than in a 1:3 mix. The reason for this result seems to be that the 1:2 mix gives an excess of mortar for both sands, whereas in the 1:3 mix the effect due to the finely divided state of the sand, or to the excess of voids, is emphasized by the leaner mix.

Recent experiences in testing concrete aggregates have indicated that the present briquette test of sands may be of questionable value when one attempts to discriminate among different sands which are offered for use. This has led to inquiry as to whether or not compression tests of sand mortars, or compression tests of concrete in which the fine aggregate is used may not be expected to furnish a better criterion as to the concrete-making quality of the material.

The earlier experimenters were in the habit of testing in compression the two halves of the briquettes resulting from the tension tests of mortar. However, on account of the irregularity of the specimen, and the difficulty of applying the load centrally, such tests have not been considered of much value. The methods of test recommended by the Committee of the Am. Soc. of Civ. Engrs. requires the use of 2-in. mortar cubes for compression tests. These specimens are stored in the same way as the briquettes. This form of specimen has not been widely used in this country, although it is a standard form in Germany.

It has long been recognized that the dimensions and shape of a compression specimen of a material of the nature of concrete and mortar have an important influence on the strength and on the uniformity of the results. Tests on concrete show that the use of a cylindrical specimen having a length equal to two diameters has distinct advantages. In a specimen of this form the influence of the frictional resistance of the bearing plates of the machine is not such an important factor, since the natural lines of stress are not interrupted. Specimens of cylindrical form are much more easily made and handled. The strengths obtained in specimens of this kind more nearly correspond to the strength of the concrete in the structures. For this reason the values from such a test are more representative. The lower breaking loads enable larger specimens to be tested in a machine of a given capacity. With a length equal to two diameters, small differences in length do not have such an important influence on the resulting strength.

It has been found that 6-in. concrete cubes show a compressive strength of about 125% of that of 8-in. x 16-in. cylinders from the same concrete. It seems probable that a similar ratio holds for mortar specimens of the same relative sizes.

The methods of conducting strength tests of mortar and concrete described below are those in use at the Structural Materials Research Laboratory, Lewis Institute, Chicago. Briquette tests of sand mortars are always made, since these tests form the basis of the present specification requirements. However, it is felt that the compression test is a better criterion of the concrete-making quality of a fine aggregate. The methods of making briquette tests do not differ from those used in other laboratories, since they follow the recommendations of the Committee of the Am. Soc. of Civ. Engrs. Compression tests are made on cylinders having a length of two diameters. Cylinders of 3″ x 6″, 2″ x 4″ and 1½″ x 3″ have been used for mortar tests of fine aggregates; 8″ x 16″, 6″ x 12″, 5″ x 10″ and 4″ x 8″ for concrete tests of coarse aggregates. Unless it is desired to study the effect of size of specimen, 2-in. x 4-in. specimens are used for mortar tests and 6-in. x 12-in. for concrete tests.

Fig. 1 shows a steel-top table and the equipment necessary for making briquettes and compression specimens of cement or sand mortars.

Architectural papers are referring to the use of reinforced concrete in church construction and cite the Cathedral of Poti in Russia as a type of an entire building being erected with this material. Another use that is referred to is a new one, namely, that of adding towers and spires of concrete in order to complete an unfinished church.

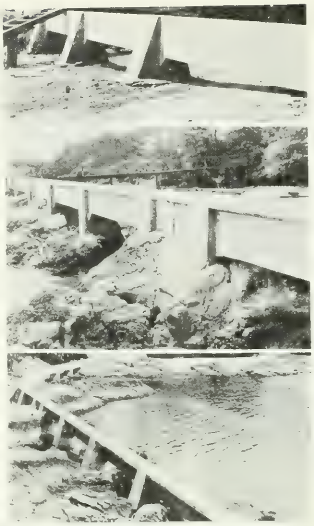

Fig. 1 First Section of Breakwater
Figs. 2 and 3—Third Section, Showing Concrete Sidewalk

A Reinforced Concrete Breakwater

By D. C. Findlay[1]

The purpose of the breakwater described in this article is to prevent the waves caused by high tides, accompanied by strong winds, from undermining the lawn and grounds of an estate. As damage is done by exceptional storms only, it was not considered necessary to exclude the water entirely, but rather to construct a wall that would break up the heavy seas, and dissipate their energy.

The foundations necessitated three types of wall: A pier and reinforced beam structure on piers sunk in the sandy beach; a low gravity section wall on rock; and a section of pier and beam wall on rock which was so badly seamed and broken that it would have been difficult to build a solid wall the entire length; consequently, it was decided to build a structure of piers, located on available ledges; and connected by heavy reinforced concrete beams.

As the maximum variation of the tide was about 12′ the site was exposed at low tide, and workmen excavated the spread footings of the first sections to good bearings, and a reinforced concrete footing was poured, on which the piers were built. Fig. 1 shows this portion of the wall. The gravity type wall was selected for the second section, as the foundations were suitable and the height of the rock required only a shallow wall; this wall was 12″ wide op top, battered back 1 to 4. It was tied into an existing retaining wall. The third section, shown in Figs. 2 and 3, supports a reinforced concrete walk 6″ thick by 2′ 6″ wide, with a galvanized pipe hand railing along each side, not shown in the illustrations. The height of the wall was fixed at 18″ above extreme high tide. Beams were made 12″ wide by 36″ deep and were reinforced with three bent, and two straight ¾-in. round rods with the necessary stirrups, Fig. 4.

At high tides, the waves break against the wall, are reflected and broken up; the water behind is quite calm. At low tides the water is not obstructed and does no damage. A set of concrete steps leads up to the lawn, and the walk leads to a private boat house at its far end.

The breakwater has passed satisfactorily through the severe storms of two winters. It was designed by D. C. Findlay, C. E., for Lieut.-Gov. Barnard, and was constructed by Naylor Bros., Victoria, B. C.

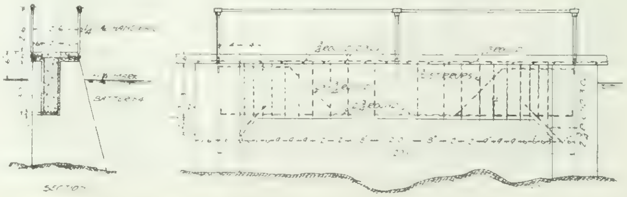

Fig. 4 Detail of Beam and Foot Walk

The London *Daily Mail* from Rotterdam says:

> Smuggling of oil into Belgium and Germany across the Dutch frontier has become a fine art. This week a suspicious Dutch customs officer at Rotterdam tapped a cement block on a railway truck with a hammer and benzine poured out of the block. Several railway wagons were found fitted with block, each containing nearly 8 gals. of benzine. Last week tombstones, said to be for marking the graves of German soldiers in Belgium, were found to be hollow and filled with benzine.

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Some *How-They-Do-It* Details from the Concrete Products Field

By Harvey Whipple

Here are eight pages of notes for makers of factory products of concrete. This material is fragmentary but informative. Let us suppose a convention of concrete stone manufacturers—an experience meeting—with no formal papers and finished discussions. The talk is right out of the shop. Only by working over such experience in the field can it establish itself in general practice or be finally discarded for something better.

Selling and Cost Keeping Ideas from Barberton

Products manufacturers reading **Concrete** will remember an article published in the Sept., 1914, issue describing in considerable detail the layout and the equipment of the new plant of the O. C. Barber Concrete Co., Barberton, Ohio. This plant began operations in the early fall of 1914 and in spite of the unusually large investment in this enterprise for building, equipment, gravel plant machinery, etc., the first year's operation shows a balance on the right side of the ledger, making full allowance for depreciation, interest on investment and other items of expense in factory operation. The plant is under the management of P. E. McAllister.

It is not the purpose here to go into all the details of the operations but merely to consider some of the features of the business system adopted by this company in *getting* business and in *taking care of it,* measures which it is believed have to a great extent been responsible for the unusual success of the factory in its first year. To "come out even" at all was hardly to be expected, particularly in view of the fact that the plant has not been operated to more than one-half of its capacity, and considering also the human elements involved in getting an organization started and in getting a system into operation with men broken in to take care of their duties efficiently, under new conditions.

GETTING BUSINESS

Three men have been kept on the road after business most of the time and they have confined their work chiefly to the state of Ohio and to western Pennsylvania. These men have been calling upon architects and upon owners getting ready to build and have merely sought opportunities for the Barber Co. to bid on work to be undertaken, in competition not only with natural stone but to some extent of course with other manufacturers of concrete stone serving the same territory. Most of the first year's business has been in dimension stone and not in standard units such as concrete block.

In addition to the three men on the road the company has in the neighborhood of 100 agents, most of them in the state of Ohio. Effort is usually made to secure for a local agent a building supply man with standing in the community and in return for his efforts he has been paid from 5% to 10% commission on the job, the amount depending upon various conditions, such as the amount of assistance given by the field men operating directly from the home office.

A further effort in getting business has been in equipping all local agents with complete lines of sample stone and in being generous with architects in the matter of samples.

Among the more important contracts in this first year's operation have been 17 public school buildings and six churches.

OFFICE AND SHOP SYSTEM

When a set of blue prints is received in the office of the Barber Co. for the preparation of an estimate an office order is first made out. This office order is to cover only the matter of the preparation of an estimate. The office order card gives sufficient information as to the owner of the building, the architect, the kind of stone, etc., and is sent with the blue prints to the drafting department where the blue prints may be split up for rough detailing of the pieces required and for the preparation of an estimate by one of three different men, including Mr. McAllister. A sample estimate sheet is shown in an accompanying illustration, which gives an idea of the detail entered into merely to prepare an estimate in advance. Record is kept of this on a Quotation Record card, a sample of which is shown in Fig. 2. This is placed in a follow-up file and it is the duty of the sales department to keep in touch with architects and builders until order is placed. The card is then filed for further reference later on, if the job comes in to be done.

A careful record is kept of the time required in the drafting department and in estimating and the cost of this preliminary estimate is recorded and is designated as belonging to a certain job. It is sent to the cost-keeping department. If the order is received the cost of the estimate is charged against the job; if order is not received, this cost is charged against overhead expense. One man gives his entire time to cost records and one young woman assists on this work.

When the order comes in on an estimate, the drawings are gone over in the sales department to determine just when certain stone for various parts of the work are required. This, of course, usually follows a certain definite order and the first shipment will undoubtedly include the base course and everything below the base course, if the work is for the trim of an entire building. The card shown in Fig. 3 is filled out and sent to the drafting department so that details may be prepared promptly for that part of the work which is to be done first. A job card as shown in Fig. 4 is made out in the drafting department and sent with full-sized details, if these are necessary, to the pattern department, going first, however, to the foreman of the shop. A copy of a shipping order to correspond with

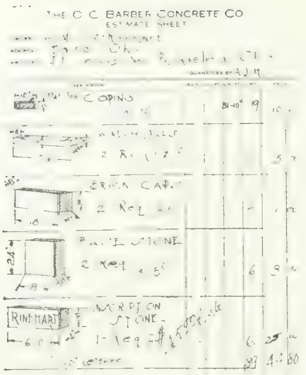

THE O. C. BARBER CONCRETE CO
ESTIMATE SHEET

FIG. 1 SAMPLE ESTIMATE SHEET

all of the various pieces shown is sent to the shipping clerk, who keeps in touch with the foreman. It is the responsibility of the foreman of the pattern department to get out the necessary molds so that they may reach the shop and the pieces be cast and given sufficient time for curing so as to be ready on the shipping date.

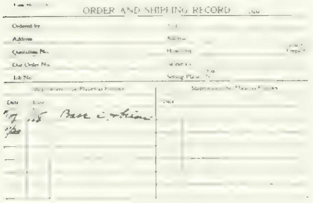

ORDER AND SHIPPING RECORD

FIG. 2—QUOTATION RECORD CARD, O. C. BARBER CONCRETE CO.

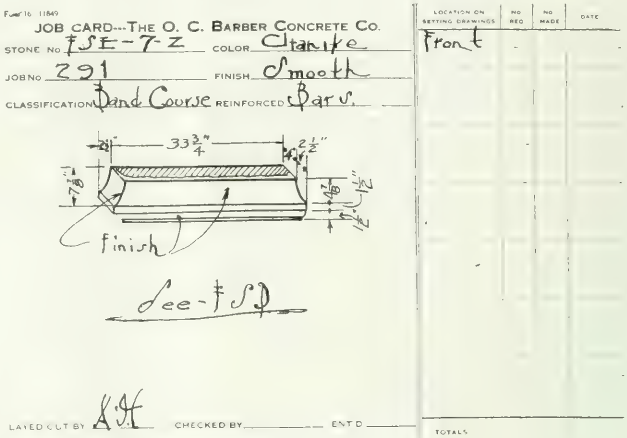
COST RECORDS

Every man keeps a time card for himself. Every draftsman indicates the number of hours and minutes that he spends on stone details for a given job; the pattern department men indicate the time they spend in preparing the patterns and molds; the molding department indicates the time spent in making each piece and all this record, properly identified as to the number of the job and the number of the stone, goes to the cost department. This cost information, being gradually accumulated, is of course of increasing value all the time, to the estimating department in making close figuring possible.

A complete record is kept not only of the cost of these operations but also the cost of the material used in the work.

QUOTATION RECORD

FIG. 3—CARD INDICATING DATES ON WHICH VARIOUS PARTS OF STONE JOB MUST BE SHIPPED


Form 16 11849
JOB CARD---THE O. C. BARBER CONCRETE CO.
STONE NO. FSE-7-Z COLOR Granite
JOB NO. 291 FINISH Smooth
CLASSIFICATION Band Course REINFORCED Bars.
LAYED OUT BY A.H. CHECKED BY ______ ENT'D ______

LOCATION ON SETTING DRAWINGS	NO. REQ.	NO. MADE	DATE
Front			
TOTALS			

33¾"
2½"
finish
See-#SD

FIG. 4 JOB CARD, DETAILING EACH STONE

The Barber plant is equipped with an electric, overhead, monorail, trolley system[1] to convey mixed concrete from the level of an intermediate floor or mezzanine 4′ below the second floor. This is just back of the molding room, over which there is no second story. The concrete is conveyed in the mixers in bottom-dump buckets direct to hoppers above the machines or into hoppers convenient for the use of men in the dimension stone department. In this department it is conveyed from the large hoppers, in boxes on special trucks[2] alongside the bankers where the stone is being made. A record is kept of the supply of mixed material each step of the way.

The man in charge of materials for the Barber Co., (which is also dealing in building materials besides using large quantities) charges the mixer man with the materials delivered to him. The mixer man charges each molder in the shop with the material sent out in the buckets over the trolley to his particular station. In this way there is a record for the cost department not only of the mixed materials delivered by the mixer man to each molder but the cards from the molder on which he itemizes the time he spent on each piece, checks against the materials, inasmuch as the dimensions of the pieces are known. Gravel is delivered by a belt conveyor from the gravel plant, which is at a little distance from the factory proper. The belt conveyor deposits the material

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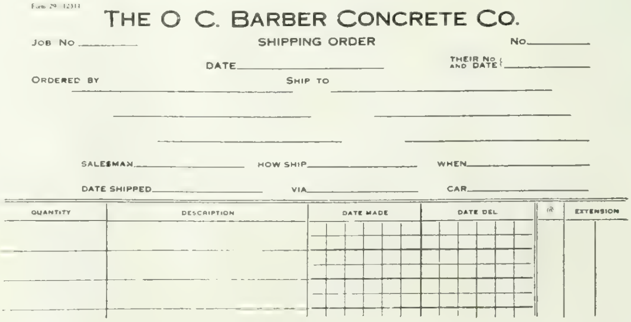
[1] Brown Hoisting Machy. Co., Cleveland, Ohio

[2] The Equipment Mfg. Co., Warren, Ohio


THE O. C. BARBER CONCRETE CO.
SHIPPING ORDER
JOB NO. ______ No. ______
DATE ______ THEIR NO. AND DATE ______
ORDERED BY ______ SHIP TO ______
SALESMAN ______ HOW SHIP ______ WHEN ______
DATE SHIPPED ______ VIA ______ CAR ______

QUANTITY	DESCRIPTION	DATE MADE	DATE DEL.	@	EXTENSION

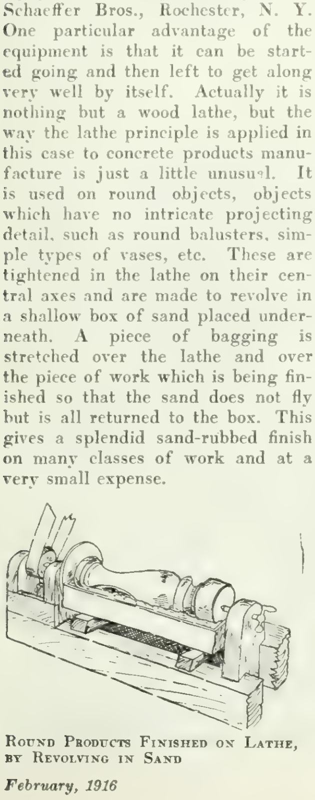
FIG. 5—SHOWING FORM OF SHIPPING ORDER

in bins of 10 cu. yd. capacity which feed into ¾-yd. measuring boxes, thence directly into the hoppers of continuous mixers. Material is let down from the 10 yd. bin to the measuring box and by means of a sliding gate is dropped into the mixer as needed. This arrangement furnishes a check on the gravel used. The layout of this equipment was described in connection with the article published in the Sept., 1914, issue.

At the present time the force of the Barber plant consists, besides the manager, of a sales manager, a cost man, a bookkeeper, and two young women. There are eight men in the drafting department, including the foreman, four men in the modeling and pattern shop, and four men in the wood working department. The total number of employes is about 90.

Lathe Used in Finishing Surfaces of Some Circular Products

There is an interesting piece of equipment in the products plant of Schaeffer Bros., Rochester, N. Y. One particular advantage of the equipment is that it can be started going and then left to get along very well by itself. Actually it is nothing but a wood lathe, but the way the lathe principle is applied in this case to concrete products manufacture is just a little unusual. It is used on round objects, objects which have no intricate projecting detail, such as round balusters, simple types of vases, etc. These are tightened in the lathe on their central axes and are made to revolve in a shallow box of sand placed underneath. A piece of bagging is stretched over the lathe and over the piece of work which is being finished so that the sand does not fly but is all returned to the box. This gives a splendid sand-rubbed finish on many classes of work and at a very small expense.



Round Products Finished on Lathe, by Revolving in Sand

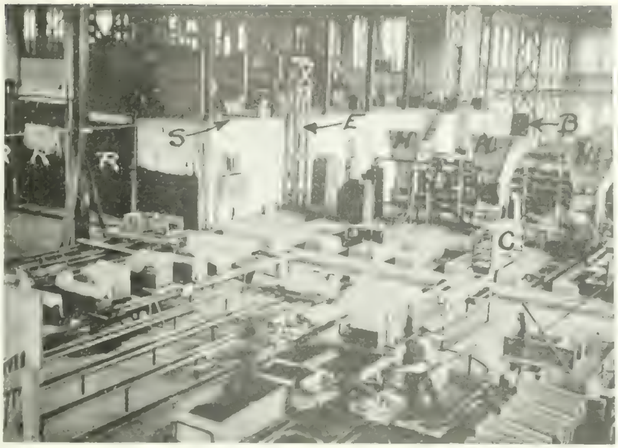


Fig. 1. General View in Molding Room, 219′ Long, Plant of O. C. Barber Concrete Co., Barberton, Ohio

Equipment and Operation of a Large Products Plant

This is just a picture story but the reproductions of photographs made in the plant of the O. C. Barber Concrete Company, Barberton, Ohio, probably the most elaborately equipped concrete products plant in this country, will carry some ideas which should be useful to men in concrete products manufacture, whose factories, though smaller, demand the same care in efficient operation.

The main building is 219′ wide and 289′ deep. Fig. 1 is a view taken of the main molding and casting room looking from corner to corner, the camera having been placed on a narrow balcony on the second story level. This balcony or runway, which is placed on brackets (seen in the upper right hand corner of Fig. 1) serves as a means of communication between the drafting room which is in the second story of a projecting wing on one corner of the front of the building and the modeling department which is on the second floor of a wing at the other front corner and between both of these and the second floor over the rear of the building. This main molding and casting room is 219′ wide. At S is shown an intermediate level about 4′ below the level of the second floor. In reality this is a balcony or mezzanine on which a battery of mixers has been placed to serve the big room in front. The body concrete is delivered to the various molders and machine operators in bottom-dump buckets (one of which is shown at B). These buckets are part of an overhead monorail system[1] operated by electricity, with tracks and switches so arranged that a bucket of concrete may be delivered to any operator and dumped into the hopper above his machine. Facing material, which is also mixed on the balcony, is placed in 1-cu. ft. boxes and lowered by means of the elevator shown at E.

There are 14 curing tunnels and the doors of four of them are indicated at R. In the near foreground is the space devoted to the manufacture of dimension stone. It is seen that the rails or bankers are placed on iron pipe supports which are screwed into pipe flanges set in the concrete floor in such a way that the standards can be removed at any time and their location changed simply by screwing the standards into different flanges. The floor is thus left clear when the standards are moved. Farther back in the picture are block machines and special note should be taken of the big hoppers indicated at H, into which a supply of concrete is dropped from the traveling bucket.

The four-deck cars,[2] one of which is indicated at C, are of a special type built of channel iron, and it will be noted that they stand in pits 12″ below the main floor level. This makes it possible to use the fourth deck of the car without too high a reach for the block maker.

In Fig. 2, is a view of a part of the mixer battery on the mezzanine floor. Continuous mixers[3] are used

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[1] Brown Hoisting Machy. Co., Cleveland, Ohio

[2] Atlas Car Mfg. Co., Cleveland, Ohio

[3] Kent Machine Co., Kent, Ohio

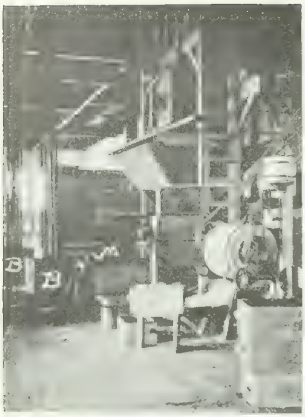

Fig. 2 Part of the Mixer Battery on Intermediate Floor Level

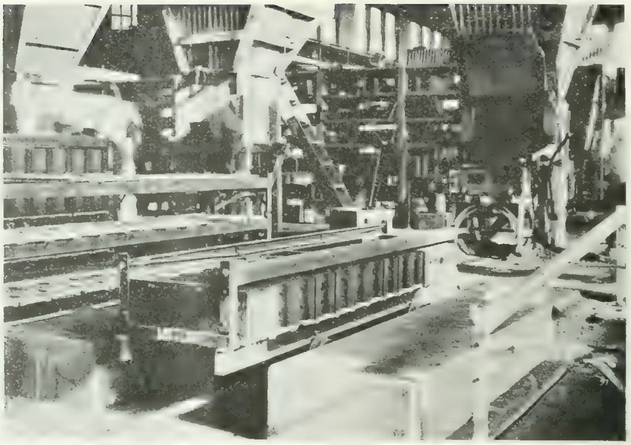

Fig. 4 Block Car and Block Machines

with special hoppers which are kept filled from bins above, the bin supply being replenished by a conveyor belt[4] from the gravel plant which is at a short distance from the factory. The mixer in the picture shown at M is one of three. It feeds into the electrically operated buckets, one of which is shown at B. There are eight of them of 8 cu. ft. capacity each. Facing materials are prepared in Blystone[5] and in Jaeger[6] small batch mixers. Boxes used to hold facing material are shown in the lower right corner and one of the boxes is shown immediately in front of the small batch mixer. Each box holds 1 cu. ft.

In Fig. 3 is a near view of a row of block machines, showing the big hopper construction above them by means of which the operators are kept supplied with concrete. The convenient location of the elevator by which the boxes of facing mixture are delivered is shown again at E. This row of machines is at right angles to the mezzanine floor on which the mixer stands.

The special 4-deck block cars have already been mentioned and a nearer view is shown in Fig. 4 with the block machines in the background. This view gives a good idea of the construction of the pits in which cars are run in order to be at a better level for loading. It will be noticed that the rails on which the cars run do not project above the floor but are flush with grooves cut when the concrete floor was laid.

In Fig. 5 are two views showing one of the hoppers which serve the dimension stone department. In the

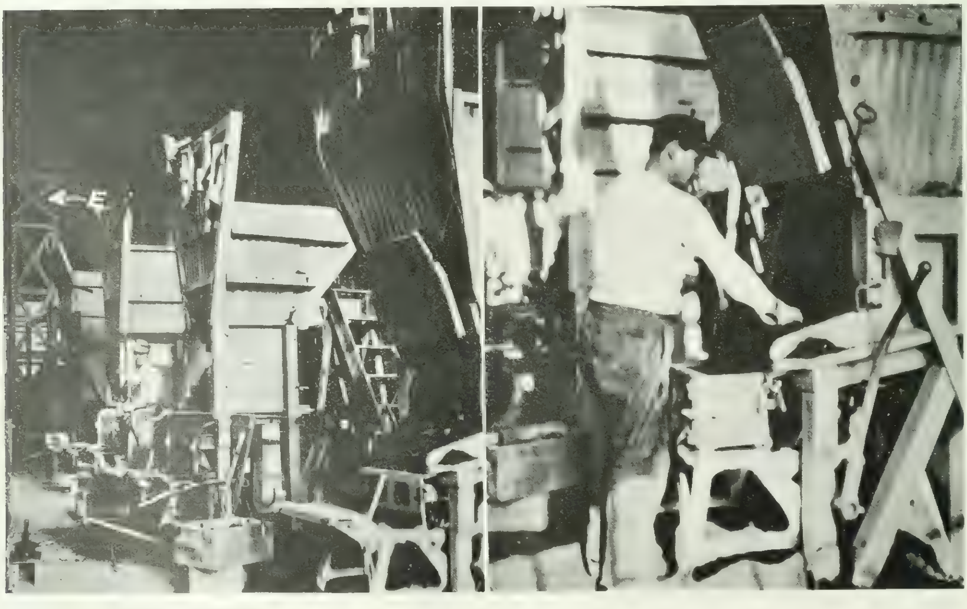

Fig. 3—Row of Block Machines

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[4] Conveyor System, Union Eng Co., Cleveland, Ohio

[5] Blystone Mfg. Co., Cambridge Springs, Pa.

[6] Jaeger Machine Co., Columbus, Ohio

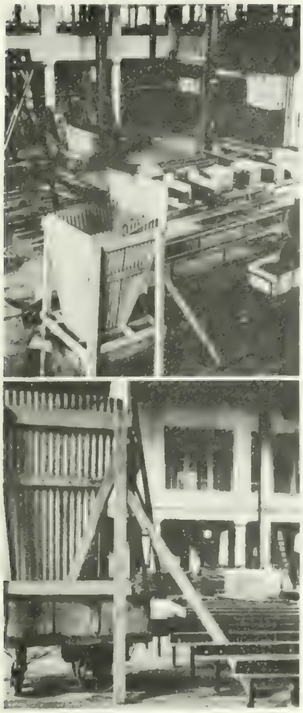

Fig. 5 Hopper and Special Car for Concrete Used in Dimension Stone Department

upper view the electrically driven bucket is dumping but the movement was too fast for the camera because it was necessary to take a time exposure. This view is looking down on the hopper from the balcony level. In the lower view a car is shown as run under the hopper to be filled with concrete. This is a special car[7] designed to run between the bankers and serve the dimension stone molders.

Four and a half mi. of concrete fence flank the rapid transit road just constructed on Long Island as a part of the Sea Beach Line improvement. The fence is 4′ 6″ high, supported on reinforced concrete posts 7″ x 7″ x 4′ 10″, with alternate posts 7″ x 9″ for expansion, spaced 8′ 4″ o. c. The concrete consisted of 1 part Portland cement, 2 parts sand and 4 parts of small pebbles, and the work presents a most attractive appearance and practically guards the roadway for the long distance already described.

Bulk Cement in a Silo Stave Plant

There is interest in the products plant of C. J. and M. Davis, Timewell, Ill., whose principal output is Interlocking silo staves,[1] because they use bulk cement and find that it pays, with no more special apparatus than wheelbarrows and one shop car with a flat open box on it for handling the bulk material. A letter from H. Bradney, mgr. of the plant, says in part:

Bulk cement is the [illegible] thing we have. The bulk [illegible] and the sand pit are [illegible] the mixer about equidistant from [illegible] supply of material. Early in the morning we fill a flat car [illegible] it full of bulk cement and run it up to the mouth of the Winner batch mixer.[2] It is much easier to shovel bulk cement into a mixer than it is to [illegible] and clean them afterwards, to say nothing about the bother of taking care of them afterwards.

Sack cement costs us about [illegible] per bbl. to unload. Bulk cement costs us about the same, or sometimes a cent more. We use about [illegible] besides what we sell. We keep sack cement for customers.

We get bulk cement in 173-bbl. cars. The car is run on our siding almost to our bulk room. An elevated platform with only a slight incline runs from a trap door in the roof of the bulk room to the door of the car. The distance from the door in the roof and the door in the car is about 20′. Two men stay in the car and two men wheel the cement to the room, using four wheelbarrows. A car of 173 bbls. can easily be unloaded in 6 hrs. to 7 hrs.

Two men divide their time operating the mixer, making silo door frames and yarding the staves. They also keep two stave makers supplied with concrete, using wheelbarrows to carry the mix about 5′. The men making staves do nothing else except run their cars into the curing rooms. We also have fence post machines, Ideal block machines,[3] and a tile machine. But extra help is used to operate them. Silos are our principal product. The four men make a silo every two days, complete. The stave makers can average a hundred staves each per day. By adding two more men we can increase our capacity to a silo a day. The staves are tamped and handled on pallets.

We use steam curing only on tile and building block, because in curing staves with steam the whole surface of the stave must be exposed and the steam condenses and makes holes in the staves, by dripping, from the rafters. (An arched ceiling would prevent dripping—Editors.) The staves, after being left [illegible], are sprinkled by means of a hose in the yard for several days afterward. A sketch shows how the staves are piled in the yard.

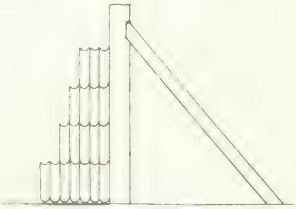

Fig. 2 How Staves Are Piled in Yard

We build and erect silos in four counties. Transportation breakage is so slight that it need not be considered at all. Freight rates are low and do not keep us from competing to good advantage with any silo firm. An average stave silo can be hauled out in 10 loads and erected in 2 das. to 3 das.

We have an X-L-All[4] tile machine which, when running, is placed where the sketch shows the block machine. It has a capacity of 4,000 tile per day, making sizes from 5-in. to 16-in. We are also equipped with hand molds for making larger sizes. We have Ideal block machines,[3] not in use all the time.

A 12-h. p. Waterloo Boy[5] engine runs the entire works. In addition to running the tile machine and mixer, it is connected to a shaft which operates a pumping jack which forces water into a large pressure tank. This gives us water any place on the grounds. The shaft also operates a steel drill.

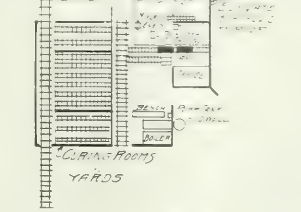

Fig. 1 Rough Outline of Layout of Davis Plant at Timewell, Ill., Where Silo Staves are Made

Sheet Steel Doors for Curing Rooms Replace Wood

When the plant of the O. C. Barber Concrete Company, Barberton, Ohio, was first used in the fall of 1914, the doors of the curing rooms were of matched lumber. Efforts were made to prevent their taking up moisture and swelling unduly, by using heavy coatings of paint. Manager P. E. McAllister says that this was not successful and that it finally became necessary to take these doors off entirely and to build up doors of sheet steel of a light weight on frames of T iron and angle iron which are now in use and are giving satisfaction. The doors work up and down, balanced by counter weights of concrete.

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[7] The Equipment Mfg. Co., Warren, Ohio

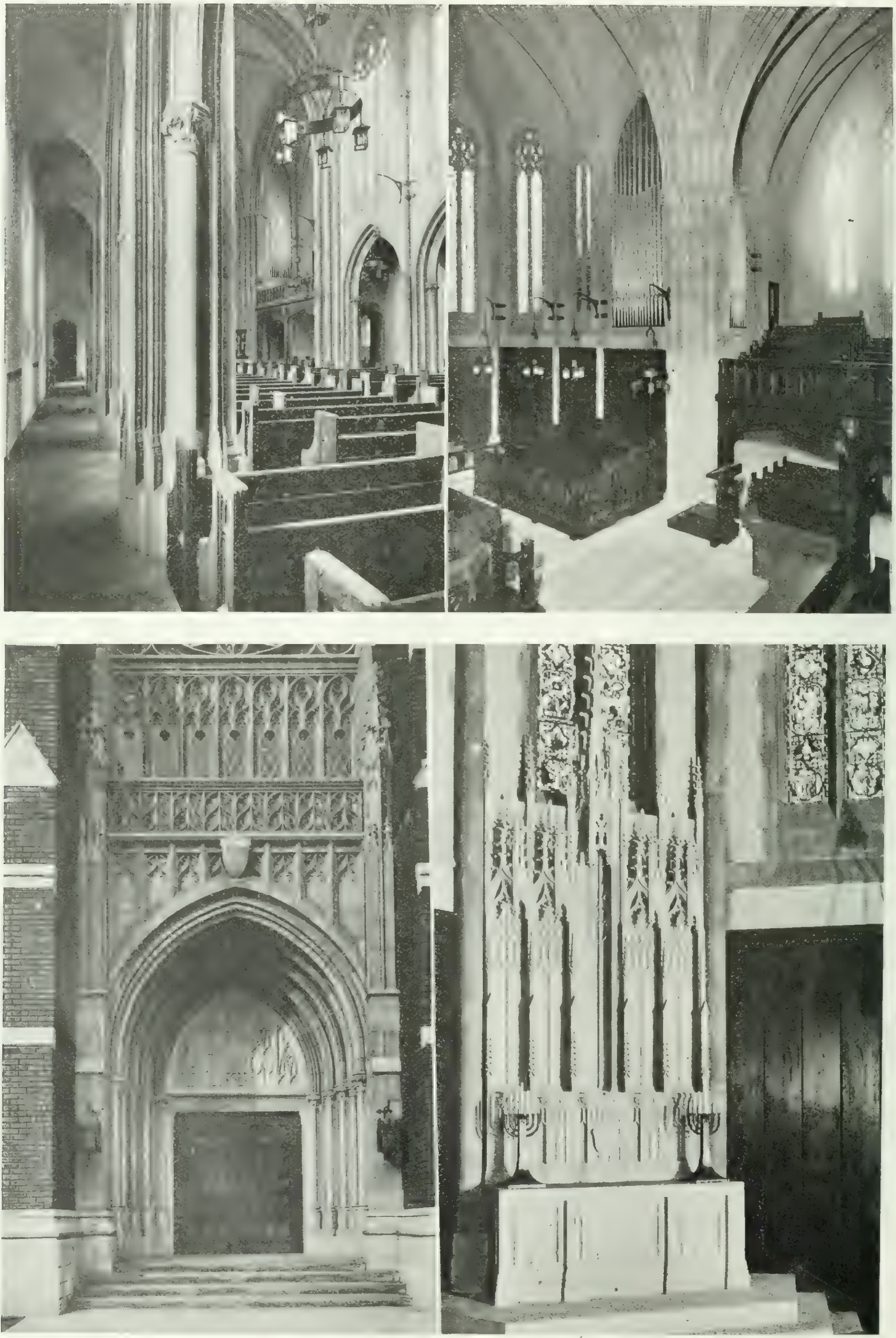
[1] Interlocking Cement Stave Silo Co., Des Moines, Ia.

[2] Cement Tile Machy. Co., Waterloo, Ia.

[3] Ideal Concrete Machinery Co., Cincinnati, Ohio

[4] Burrell Mfg. & Supply Co., Kankakee, Ill.

[5] Waterloo Gas Eng. Co., Waterloo, Ia.



Views of Trinity Lutheran Church, Akron, Concrete Stone Trim by George Rackle & Sons Co., Cleveland: J. W. Corbusier, Architect

Figs. 1-5—Making Plaster Mold from Plaster Model

Plaster Piece Mold From Carved Plaster Model

Models for a great deal of the work of a special character requiring intricate plaster molds and glue molds at the plant of the O. C. Barber Concrete Co., Barberton, Ohio, are made of plaster rather than of clay. Instead of producing the model in clay by a modeling process it is frequently produced in plaster, being carved out of a specially cast block of plaster. The rather low-grade plaster used is found to answer all the requirements of the work. The design is laid out on a rectangular block and the model is then carved in all its details. In Figs. 1 and 2 some finishing touches are being carved on this plaster model, and sectional plaster molds are being made from it. The model had already been shellacked and part of the piece mold had been made when a slight undercut was discovered just under the scroll. This the carver is seen removing. The model itself is dark in the picture shown here because of the coating of shellac. It will be seen in Figs. 1 and 2 that one piece of the mold (A) to encircle the scroll just half way at the top of the model has already been made. In Fig. 1 it is shown shoved back just a little from the scroll into which it fits. Just in

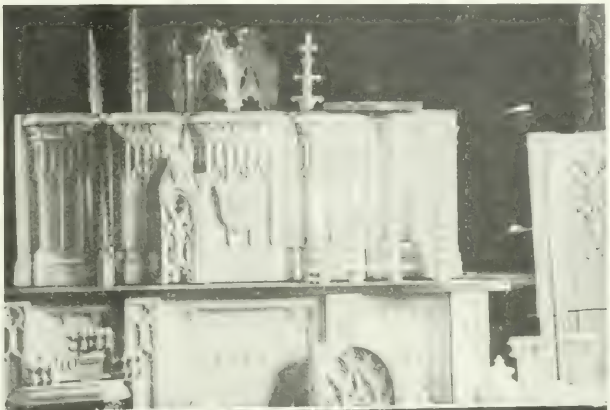


Fig. 6—Plaster Model for Altar (Shown on Page Opposite)

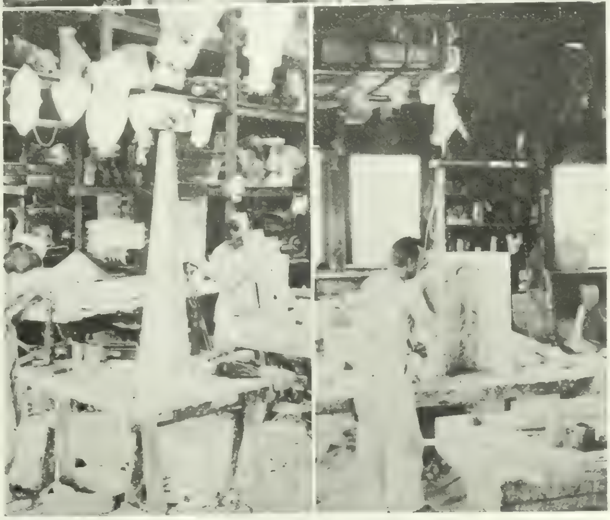


Fig. 7—Two Views of Modeling Department of Rackle Factory While Altar Models Were Being Made

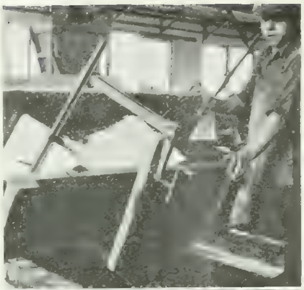
front of the hand of the carver in Fig. 1 is another piece of the mold. At C in Fig. 2, is shown the upper end of this model which has already been filled in with plaster held by small form boards clamped into place. In making these, "fences" of modeling clay were used, put on the model at the desired point and the plaster worked up to them. When the plaster is hard these edges next to the clay "fences" are carefully smoothed off, shellacked and oiled before the piece of the mold adjoining is put in. This operation is shown in Figs. 3, 4, and 5. At the top is shown the finished edge (A) of the piece marked A in Fig. 1. At B in Fig. 4 is shown a clay fence. The space on the model, bounded by the fences and by the two pieces of mold (top and bottom), is being filled with plaster. In Fig. 5, more plaster is being applied to the model. The hand of the operator is shown rather indistinctly, applying the plaster. The pan in which the plaster was mixed is shown in the foreground.

On page 72 are four views of the Lutheran church at Akron, Ohio, the stone trim inside and outside having been made by George Rackle & Sons Co., Cleveland. The altar is a concrete stone in reproduction of Caen stone. This altar includes an immense amount of very fine detail—some of the finials including detail smaller in section than a pencil. It is interesting in connection with the consideration of models carved in plaster, that the altar models were made in this way. In Figs. 6 and 7 some of this work is shown in progress in the Rackle factory.

Polishing a Concrete Table Top

In the accompanying illustration a workman at the plant of the O. C. Barber Concrete Co., Barberton, Ohio, is shown polishing a table top using a carborundum disc[1] on a polisher driven by flexible shafting. There are a number of such polishing equipments on the market now and the working heads can be fitted with grinding discs in various degrees of fineness and in various shapes to get at different kinds of work, some being suited to cutting out very fine details[2].

Polishing Table Top with Motor-Driven Disc



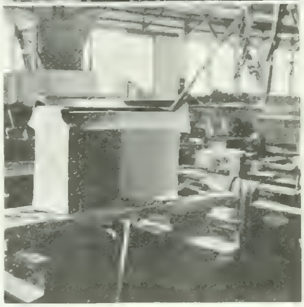


Fig. 1 Turning Dimension Stone Over for Removal of Plaster Mold
Fig. 2 Part of Mold Removed

Making a Piece of Dimension Stone

Figs. 1 and 2 show a dimension stone of intricate section in the making. This is at the plant of the O. C. Barber Concrete Co., Barberton, Ohio. The plaster mold has been tamped full with exposed faces down and at the side and after the mold is filled the surface is covered over with bedding sand to a depth of about $\frac{1}{2}''$ and carefully leveled by sliding the pallet over it by a light easy movement. The pallet is then clamped down as shown in Fig. 1. The near side as shown in Fig. 1 was the top of the mold. In Fig. 2 the original pallet on which the mold stood has been removed and the top, (the bottom as molded) and one side of mold taken off. It will be noticed in the lower right-hand corner and in the lower left-hand corner of the dimension stone as it rests on the pallet in Fig. 2, there are light triangular areas. These are bedding sand. The stone is complete as designed without these corners but in view of the fact that the block had to be turned over to rest on the top side, there was likelihood that the concrete above these corners might fall out. Therefore the corners were filled in, after all the concrete had been placed, with bedding sand so that the corners of the stone would have something on which to rest when turned over.

In Fig. 3, the surface of a freshly made piece of concrete stone is being sprayed from a small hand-sprayer of the type used by florists in spraying plants. The spray is nothing but water. The additional moisture is needed by the facing and besides that it has a tendency to brighten the facing by removing a part of the cement which coats the facing aggregate.

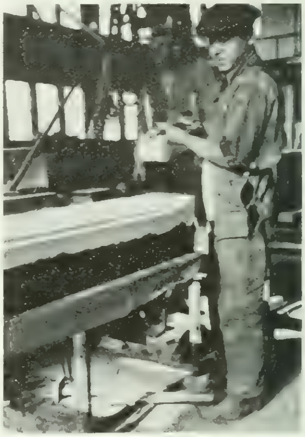


Fig. 3 Spraying Freshly Made Stone with Water

New "Cure" for Crazing

M. J. Griffith, employed in the pattern department of the O. C. Barber Concrete Co., Barberton, Ohio, in talking of methods of preventing crazing and of closing up the pores and hardening the surface of concrete stone where special precautions are to be taken against both absorption and wear, says that he has found great satisfaction in the use of a mixture of cotton-seed oil cut with a little turpentine. This he has painted onto the concrete stone after a short curing period in which the surface has dried out. He says that this prevents to a very great extent the crazing which is the bane of many concrete products manufacturers and increases surface density.

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[1] Carborundum Co., Niagara Falls, N. Y.

[2] E. Cavitchi, Quincy Adams, Mass.

Mr. Griffith also says that he has used a mixture of 1 lb. of stearic acid heated with 1 gal. of kerosene. When this is applied in the same way that the other mixture is used, Mr. Griffith has found that the resulting surface is too hard to permit any finishing of the concrete stone, such as rubbing or ordinary tooling. He finds that this treatment is objectionable on this account. It might be worth trying, however, where great hardness is wanted and no surface finishing is to be done.

Sand Molds for Making Steps

Enough has been said in CONCRETE from time to time on the use of sand molds in making concrete stone so that the general methods and operations involved are understood. Most of such work referred to has been factory work and the use of sand molds by contractors to meet special requirements of a particular job is not common.

In certain classes of work it becomes convenient to use a process of sand casting, for an irregular concrete form which is to be repeated over and over again. The way this is done is in all respects analagous to the casting of iron. The wooden pattern used to prepare the mold in sand is handled in exactly the same way as the pattern for a metal casting. An interesting example of this class of work was done several years ago by the Aberthaw Const. Co., Boston, in making the concrete seats of the Harvard Stadium.

To the casual observer inside the stadium, the massive structure of concrete looks to be a monolith, with the exception, perhaps, of the colonnade around the top, which was added after the Aberthaw Const. Co. had finished the structural part of the work. As a matter of fact, however, these seats were made in sections, and what now appears to be simply expansion joints between them are actually joints between separate castings. The sketch in Fig. 1 shows how these separate sections of seat were placed upon the steel structure which supports them.

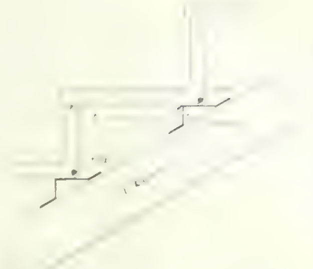


Fig. 1

The molding was a simple matter, in which the pattern was placed upon the drag (d), Fig. 2. Sand was then rammed all around it (bb) within the flask. A hollow wooden core, placed at one side of the flask as shown, made it unnecessary to use large quantities of sand, and what is more important, largely reduced the weight to be handled. Then sand was rammed up around the top (cc), and the top board put in place and clamped.

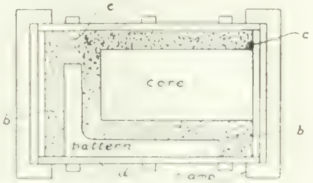


Fig. 2

The whole thing was then turned upside down with the aid of a small jib crane. Upon removing the drag (d), and the wooden pattern, the form was ready for the insertion of reinforcement in the same way as a mold for an iron casting is completed by the insertion of cores.

Clinton[1] wire cloth with a good-sized mesh was used, as shown in dotted lines in Fig. 1, with a single twisted rod at one corner, as indicated. The cement used was in the proportion of 1:2:4, small-sized stone being required because of the small space into which the concrete had to be poured.

The hard packed sand gave a finish to the concrete seats which was final. Nothing more remained to be done in preparing them for erection, with the exception of a little smoothing in some cases at the points (e) at which they came in contact with each other and with the steel structure.

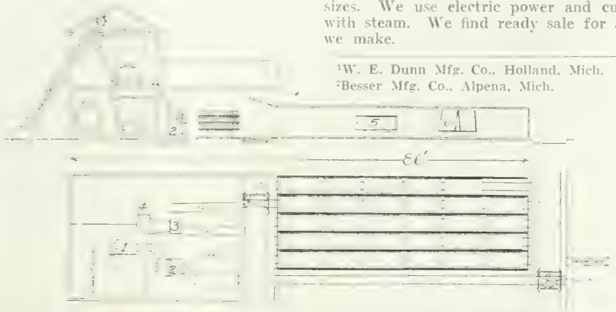
The under side of the seat as erected is the surface which is free to the air when cast. Any irregularities appearing in it are hidden by the way in which the seats were erected.

Successful in Drain Tile Plant in First Year's Operation

The accompanying plan and sectional elevation show the concrete products plant of Joy & Son, Napanee, Ont., where drain tile, sewer pipe, block, brick and ornamental work are made. By means of a chute from the mixer at the second floor level, mixed concrete is brought to any one of these machines.

An "experience" letter from Joy & Son is in part as follows:

> We started to manufacture concrete brick, block and tile in 1910, under an open shed, but have since put up a building, 60′ x 80′, as shown in the illustration. We made tile with hand machines, until we got them introduced. The farmers were skeptical of them at first, but we finally got them to using them in preference to clay tile; in fact, the clay tile yard closed after the first year, and has not made any since. We installed a Dunn power tile machine,[1] which gave good satisfaction, and which we are still using for the smaller sizes, using a Besser machine[2] for the larger sizes. We use electric power and cure with steam. We find ready sale for all we make.



Plan and Section at Elevation of Joy & Co.'s Concrete Products Factory, Napanee, Ont.

Mixer is at 1 (second floor) with cement platform back of it; 2, tile machine; other machines, not always the same, at 3 and 4—all three machines fed by chute from mixer on floor or platform above; 5, tile or block car; 6, brick car; 7, transfer; 8, portable track

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[1] Clinton Wire Cloth Co., Clinton, Mass.

[1] W. E. Dunn Mfg. Co., Holland, Mich.

[2] Besser Mfg. Co., Alpena, Mich.

Is Concrete a Good Sewer Material?—Let 49 Municipal Engineers Answer

Manufacturers of concrete sewer pipe and contractors for sewer construction are often confronted by statements to the effect that concrete is not a suitable sewer material. The claim is sometimes made that the acids present in sewage and the gases evolved have an effect in the deterioration of concrete to such an extent as to make its use inadvisable.

In order to determine to what extent concrete is being used and the measure of truth in the contentions of the opponents of the concrete sewer, letters were addressed to 94 cities in which concrete sewer construction was carried on in 1914. The essentials of the replies are reproduced and should convince any fair-minded person that there is no better sewer material than concrete. The testimony of 50 representative city engineers is not to be regarded lightly.

The advantages of concrete sewers are numerous; some of them were stated briefly by L. R. Ferguson[1] in a paper presented at the convention of the Am. Concrete Pipe Assn., Feb., 1915. Mr. Ferguson said in part:

> In 1872 concrete pipe was used in the sewers of Alleghany, Pa., and as long ago as 1861 the city of Brooklyn, N. Y., built sewers of concrete pipe. In the latter city they now have upwards of 500 mi. of sewers of this type. Paris and Vienna have long used concrete sewer pipes. In fact, these cities use practically no other type of construction.
>
> Concrete sewer pipe possesses many advantages over other types of sewer construction and these advantages are being rapidly recognized. * * *
>
> In many sections of the country, concrete pipe must compete with terra cotta. Here, again, reinforced concrete pipe possesses many distinct advantages. The reinforcement and wall thickness in concrete pipe can be made sufficiently strong to resist practically any earth pressure. Concrete pipe, if properly made, does not have to be maintained, and cement possesses the quality of increasing in strength with age. The possibility of molding concrete pipes to any shape desired is, of course, a very great advantage and equally important is the fact that concrete pipes can be made perfectly true, which permits the building of a sewer with joints that are absolutely flush and true on the inside. There is no warping or twisting of the concrete pipe during the process of curing, and when laid the sewer certainly offers considerably less frictional resistance to materials passing through it than do sewers built of pipes of irregular shape.
>
> The reinforced concrete pipe has proved very satisfactory in resisting infiltration. Owing to the imperviousness of the pipe walls and the closeness with which the joints can be made, infiltration can be made negligible, and a sewer may be designed without considering the necessity of taking care of any of the ground water. * * *
>
> One often hears that concrete pipe, if suitable for sewers at all, can be used for storm water sewers only. It has been very frequently suggested that the acids from sewage will rapidly disintegrate concrete pipe. I believe this to be very largely a myth. In this day, when increased efficiency is the slogan of practically every manufacturing establishment, it is not customary to allow valuable by-products to be wasted and run into sewers. Paper mills and other factories using acids are not throwing away concentrated solutions of this very valuable material. So far as the action from ordinary sewage is concerned, while it has been claimed that a deteriorating effect occurs above the flow line, the many concrete monolithic sewers which have proven satisfactory after years of use and which show no deterioration, refute this contention. So far as the action below the flow line is concerned this is simply a question of wear caused by friction and the concrete in concrete sewer pipes is no different from the concrete in monolithic sewers.
>
> Without doubt there is an enormous field opening up for concrete sewer pipes. In the eastern section of the country, where concrete comes in competition with pipes of other material, even though brick and terra cotta can be readily obtained, the concrete pipe is overcoming opposition and is securing attention not only through its intrinsic merits, but also on the question of price. In the far West where shipments of terra cotta pipe made over long distances involve breakage and high freight rates, and where deep ditches are often necessary, thus producing an over-load which terra cotta pipe is unable to sustain, concrete pipe should have the field to itself.

In the letters which follow a great deal of stress is laid upon economy of concrete sewer construction. An interesting series of bids illustrating this phase of the subject was received by the sewer department of Baltimore, Md., within the last few years. These bids are reproduced in tabular form and are by no means an isolated instance of the economy of concrete. It will be remembered that Baltimore is in an especially favorable location in which to receive favorable bids for brick and tile construction.

The following four questions, which were intended to indicate the amount of concrete sewer construction which has been done and the satisfaction which it is giving to users, were sent to 94 city engineers. Forty-nine replies were received, dated July and Aug., 1915, the essentials of which are reproduced. They indicate to a remarkable extent the satisfactory service of the concrete sewer.

1. How long and to what extent have you been using concrete sewers?

2. Why did you adopt concrete for sewers? What advantages did you expect and what advantages did you gain?

3. Are you satisfied with concrete sewers (pipe or monolithic), and if not, what is the cause of your complaint?

BIDS FOR SEWER CONSTRUCTION, BALTIMORE, MD.

Contract No.	Size and Shape	Brick	Mon. Concrete	Con. Pipe	Vit. Pipe
26	48″ round	$5.80	$5.60	$5.15	....
26	42″ "	5.15	4.95	4.35	....
22	36″ "	4.25	3.50	3.25	....
26	36″ "	4.25	4.00	3.50	....
28	36″ "	4.40	4.60	3.25	....
22	33″ "	3.75	3.50	2.55	....
26	33″ "	3.25	3.80	3.20	....
28	33″ "	3.95	4.10	2.85	....
31	33″ "	5.00	4.00	2.25	....
22	30″ "	2.90	2.20	2.50	$2.25
26	30″ "	3.25	3.00	2.40	3.25[1]
28	30″ "	3.75	3.90	2.25	3.00
31	30″ "	5.00	4.00	2.25	5.00

[1] With concrete saddle

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[1] Asst. Secy., Assn. of Am. Portland Cement Mfrs., Philadelphia

CONCRETE

4. Will you outline briefly anything especially interesting in your use of concrete sewers, either in design, costs or results?

ALBANY, N. Y., LIKES CONCRETE PIPE

1. We first provided for the use of reinforced concrete pipe for the intercepting sewer, in 1914, a job which calls for 5,200′ of 66 in. pipe, 2,325′ of 54 in pipe, 2,300′ of 18 in. pipe, 600′ of 42 in pipe, 1,040′ of 36-in. pipe, 3,070′ of 27-in. pipe, 450′ of 24-in. pipe.

2. Because it was cheaper than monolithic concrete or brick masonry and because the pipe could be molded away from the job itself to be brought on the work as needed and thus obviate the congestion of busy streets by materials.

3. We are well satisfied in the use of reinforced concrete pipe and have since used it on several other large contracts. —Frank R. Lanagan, City Engr.

ALTOONA, PA., USES CONCRETE BLOCK SEWERS

1. Concrete has been used to some extent in constructing sewers in this city since the year 1904. The majority of sewers 24″ in diam. or larger laid since 1904 are constructed of concrete block, reinforced concrete or reinforced concrete pipe. There is now in service some 3,300 lin. ft. of concrete block sewers, about 3,700′ of reinforced concrete storm sewers and 13,300′ of reinforced concrete pipe sewers.

2. The reasons for adopting concrete for sewers were the employment of local labor, the saving in the cost, the ease in changing the cross-section to properly meet the existing conditions. For sanitary sewers the reinforced concrete pipe has fewer joints and may be constructed to reduce greatly the quantity of infiltration.

3. The sewers constructed of concrete are entirely satisfactory.

4. Last year some 6,000 lin. ft. of 24-in. Lock Joint[1] pipe were laid where the level of the ground water was from 2′ to 5′ above the tops of the pipe. The amount of infiltration water was less than one-half the quantity allowed by the specifications.—J. W. Shields, City Engr.

ATLANTIC CITY, N. J., USES CONCRETE FOR MAINS

House sewers are of terra cotta or cast iron. (Private corporation) Storm drains either terra cotta or brick arch, concrete invert. Main drain concrete entirely. In use about four years and entirely satisfactory. J. W. Hackney, City Mgr.

BATTLE CREEK, MICH., HAS USED CONCRETE TEN YEARS

We began constructing sewers nearly 10 years ago, but have confined our use largely to storm sewers. We have nearly a mile of concrete sewers, most of them over 30″. We formerly laid all our sewers with bricks, using first local Mich. bricks and for the last 15 years shale clay brick from Ohio, Ind., and Ill. We came to the conclusion after careful consideration that we could keep more money at home by laying concrete sewers and that they were cheaper and presented a smoother surface on the inside.

We are quite satisfied that we acted wisely when we changed from brick to concrete, especially since we changed from wooden forms to rented steel forms.[2] I think the gain is not very great yet I have no idea that we will return to brick and recommend concrete where the proper materials can be obtained at reasonable price. The only trouble we have is with sewers 30″ dia. or less. We use sewer pipe from 24″ down, for the reason that it is difficult to get inside the forms, yet I think even these sizes are cheaper than a brick sewer. We have used no concrete sewer pipe: it is my opinion that concrete sewer pipe can be made perfectly satisfactory. —W. W. Brigden, Supt. & Engr.

BEAUMONT, TEX.

1. Four years.
2. Cheaper.
3. Yes.

City Engr.

BERKELEY, CAL., FINDS CONCRETE CHEAPER FOR LARGE SIZES

We have had experience with concrete sewers only one year. We have used vitrified iron sections for inverts. The sewers are monolithic and have given entire satisfaction so far. We find monolithic sewers cheaper and more satisfactory for all work over 30″ in diam.—J. J. Jessup, City Engr.

BOSTON HAS NO CAUSE FOR DISSATISFACTION

1. Since 1906, general in place of brick.

2. Economy.

3. No cause has appeared up to date for dissatisfaction with concrete (monolithic) sewers.

4. The use of concrete, reinforced with steel, has made feasible the box section type of sewer, admirably adapted to cases of lack of headroom, sometimes accompanied by lack of side room. The rebuilding of Old Stony Brook is the best type of this form of construction.

By the use of steel longitudinally in the invert and the side walls many sewers have been built in questionable ground, the sewer being practically a concrete girder, spanning the soft spots, and avoiding pile driving.

Neither of the above devices would be practicable in brick. -E. F. Murphy, Com. Pub. Wks.

CAMBRIDGE, MASS., PLEASED AFTER [illegible] YEARS' EXPERIENCE

1. [illegible]

2. Cheapness and ease of construction.

3. Sewers have proved very satisfactory.

4. Inverts are usually cast in place—the arch is made in sections.—L. W. Hastings, City Engr.

CHICAGO HEIGHTS, ILL., SAYS CHEAPER AND FASTER

1. About 2 yrs. for storm water only.

2. Cheaper put in more easily and a great deal faster. Stronger and with good forms can be put in by less experienced men.

3. We are satisfied.

4. We got best results from steel forms.[1]—M. H. McCoy. City Engr.

CHILLICOTHE, OHIO, FINDS CONCRETE KEEPS ROOTS OUT

1. Nine yrs. We have 48″ and about two miles of 7 ft. x 10 ft. reinforced concrete sewers.

2. Cheaper than vitrified pipe, no joints for roots to enter, one continuous line of monolith. Less friction on account of joints.

3. Satisfied.

4. Any shape of sewer can be built with concrete at very reasonable cost.—H. M. Hadd, City Engr.

CLEVELAND HAS USED LITTLE CONCRETE IN SEWERS

This city has made but little use of concrete sewers. We have of course extensively used concrete in connection with sewer construction for foundation purposes, for backing and for arch construction. As a usual thing brick has been employed for lining the invert of sewers. So far the use of concrete in sewer construction as used here has been satisfactory.—Robert Hoffmann, Comm. & Chf. Engr.

COLUMBIA, S. C., FINDS CONCRETE CHEAPER FOR LARGE SIZES

1. We have laid a number of miles of reinforced concrete storm water drains since 1910.

2. We adopted concrete for our storm water drains principally on account of economy in construction and find it satisfactory and cheaper than brick.

3. We have found our concrete drains both of monolithic and reinforced concrete construction quite satisfactory.

4. We use either monolithic concrete or reinforced concrete in our storm drain construction, providing the drain is to be larger than 24″ in diameter. For sizes of 24″ and less we use vitrified pipe, as we find it cheaper and equally satisfactory. The larger sizes of vitrified pipe would also be satisfactory, but as the cost is much higher we have adopted concrete in the large drains.—John McNeal, City Engr.

COLUMBUS, OHIO, FINDS LESS FRICTION IN CONCRETE SEWERS

1. We have been using concrete sewers with brick inverts for the past 10 yrs. All monolithic concrete for two yrs.

2. Concrete is used because cheaper in construction and equal to brick. We still construct some brick sewers.

3. We are satisfied with concrete sewers both in pipe and monolithic construction.

4. We do not favor monolithic on small sizes on account of the possibility of getting bad spots in thin shells which do not occur on thicker shells. Concrete pipe reinforced, or vitrified segmental block are better on 24-in., 30-in. and 36-in. sizes. The depth of cut and nature of ground often determine what construction to use. All concrete sewers which we have constructed both in pipe and monolithic have proved to be satisfactory, and show less friction than brick.—Henry Maetzel, Chf. Engr.

EDMONTON, ALTA., FINDS REINFORCED CONCRETE MOST DESIRABLE

1. Between 1907 and 1910, this city constructed approximately 3.7 mi. of concrete sewers, diameters varying between 27″ and 7′.

Between 1911 and 1914 part of Edmonton's tunnel sewer system was completed, totaling 11.69 mi., diameters varying between 4′ and 10′ 6″.

2. Among brick, monolithic concrete and reinforced concrete block. Brick, very desirable as regards facility of construction but difficult to build of such strength as to withstand high internal pressure. Monolithic concrete (plain)—difficult construction, difficult to make of sufficient strength to withstand internal pressures. Reinforced concrete block, most desirable to suit all requirements.

3. Have no reason to be other than satisfied. A. W. Haddow, Acting City Engr.

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[1] Lock Joint Pipe Co., N. Y. C.

[2] Blaw Steel Const. Co., Pittsburgh

[1] Blaw Steel Const. Co., Pittsburgh

EL PASO, TEX., USES LARGE AMOUNT OF CONCRETE PIPE

We have about 3,,200′ of 16-in. and 18-in. sectional concrete pipe with bell ends and no reinforcement, in use for about 6 yrs. About 3 mi. of 24-in., 30-in. and 36-in., laid in 1913 and 1914; manufactured in 3-ft. sections with triangular mesh reinforcement and Merriweather joints.[1] Within the last year we have laid about 3,300′ of 30-in. monolithic reinforced.

Concrete pipe was adopted because we could build it for considerably less than we could buy and lay vitrified pipe or brick.

The results so far have been very satisfactory.—George Espy, City Engr.

FREMONT, NEBR., TURNS TO CONCRETE

In 1914 we laid 8,0000′ of 24-in. 2-in. wall concrete pipe of 1 cement to 2½ of sand without reinforcing. They are satisfactory in every respect, not being in very long cannot tell how they will last but believe the will last as long as any vitrified pipe. It is entirely a sanitary sewer.

The cost of the concrete pipe was considerably less than the vitrified pipe, in spite of the efforts of the vitrified pipe people to down concrete.—L. M. Roessler, City Engr.

FARIBAULT, MINN.

1. Five yrs. on storm sewers 36″ or larger.
2. Cheaper in large sizes.
3. Perfectly satisfied.
4. They were considerably cheaper than the same size in vitrified pipe.—F. W. McKellip, City Engr.

CONCRETE FOR LARGE SIZES AT GRAND RAPIDS, MICH.

1. Five yrs. or 6 yrs.
2. We use concrete on large size sewers, 36 in. and up, only.
3. Yes.—City Engr.

HAMILTON, ONT., UNABLE TO VERIFY REPORTS THAT SEWAGE DESTROYS CONCRETE

Since 1909 all sewers in this city over 24″ diam. have been constructed of reinforced concrete or sectional concrete pipes. Brick sewers were previously built. One concrete pipe sewer was put down in 1890, which is still in use.

We adopted concrete for sewers over 30″ in diameter and for manholes for sewers for the reason (1) Cheaper than brick or vitrified pipe in the sections mentioned. (2) Can be handled largely by unskilled labor.

We are very well satisfied indeed with concrete sewers; in fact, it is our standard sewer material.

I have investigated a number of cases of reported disintegration of concrete sewers and can find nothing to substantiate the statements.

Last winter (1914-1915) in order to give work to the unemployed because of conditions caused by the war, we constructed in the east end of the city a trunk sewer system, the sewer all being of reinforced concrete pipe from 66″ to 30″. These pipe were all made in an open field during nearly all conditions of the winter weather and cured by means of steam pipes running through them, with canvas tarpaulins over them to protect them from the wind and snow.[1]

I have since examined the pipe as laid in some places under 22″ of clay and have found no signs of cracks, in fact the pipe was as good as if it had been made under better climatic conditions.—A. F. Macallum, City Engr.

HANNIBAL, MO.

1. For storm sewers only.
2. Have not adopted it.

HARRISBURG, PA., HAS USED CONCRETE SEWERS TEN YEARS

We have been using concrete sewers for 10 yrs. or more. We have probably 12 mi. or 15 mi. of concrete sewers, varying in size from areas equal to dia. of 5′ and 3′. The advantage we expected and got was economy. We are entirely satisfied with our concrete sewers.—M. B. Cowden, City Engr.

HOUSTON, TEX., USES CONCRETE STORM SEWERS

Four yrs.

Because they are cheaper.

We are satisfied with concrete sewers for storm sewer purposes but not for sanitary sewers. We find that monolithic concrete sewers built in place have some advantages for storm sewer work. They are cheaper, have no joints and have a smooth barrel, fit the trench both on the bottom and sides and thus reduce the bending movement in the arch ring.—E. E. Sands, City Engr.

INDEPENDENCE, KANS., HAS USED CONCRETE 6 YEARS

Have been using 6-in. and 8-in. concrete pipe in our sanitary sewers for about 6 yrs. As yet I can not say much about the pipe compared to vitrified.—City Engr.

CONCRETE SECURES KANSAS CITY, MO., BETTER PRICES

We have been using plain concrete pipe in sewers for about 3 yrs., in sizes from 8″ to 24″. For larger sizes we use reinforced concrete pipe and reinforced monolithic concrete. From Jan., 1913, to Jan., 1915, we constructed about 35 mi. of concrete sewers, all types.

Concrete pipe was admitted to our specifications to produce competition and this advantage was gained as expected and has also resulted in our getting much better vitrified pipe than was turned out previous to admitting concrete pipe. Concrete pipe in sewer construction has given satisfaction in this city. The only difficulty we experience is in getting the reinforcing rods properly bent and placed in their proper position, and this, I believe, is due to the class of labor that is employed for this work.—H. F. Johnson, Engr. Sewer Div.

WHAT CONCRETE MATTOON HAS IS SATISFACTORY

We have two short pieces of concrete sewer only, those at the outlet of storm water sewers. We have not enough to give concrete a fair trial; however, all we have is very satisfactory.—John A. Goetz, City Engr.

MINNEAPOLIS SEWERS BUILT IN 1885 FIRST CLASS NOW

We have some concrete sewers built in 1885, which are today in first-class condition. Since 1904 we have built all sewers larger than 33″ of monolithic concrete. We have now in use 22½ mi. of concrete sewers and they are in first-class condition. Our monolithic concrete sewers are cheaper than our brick sewers and can readily be constructed of any desired thickness of shell. We are perfectly satisfied with our concrete sewers, which are very smooth and consequently easy to keep clean. We line the inside bottom of our concrete sewers with paving brick.—C. Illstrup, Sewer Engr.

NEWARK,, N. J.

1. Since 1904. About 14½ mi.
2. For economic reasons. We expected cheaper sewers and got them.
3. Yes.—E. S. Rankin, City Engr.

NEW HAVEN, CONN., THINKS WELL OF CONCRETE

1. The first cement concrete sewer was built in New Haven in 1906; a 36-in. circular sewer or sewer overflow, reinforced and on pile and timber foundation. In 1907 a 36-in. egg-shaped sewer was designed for either brick or plain concrete. The lowest bid was for the concrete design and it was so constructed. In 1908 a similar competition was offered for a 60-in. sewer but the lower bid was for brick masonry, and that bid was accepted.

In 1906 a double sewer of reinforced concrete, each tube 6′ x 4′, saucer bottom, total width over-all 16′, was built, for use, at first, as an overflow sewer, and later, when extended, it became an outfall sewer. All on piling.

A reinforced concrete sewer, about 6,000′ long, was built in three sections, in 1909, 1913 and 1914. It was part 42″ and part 36″. It is an intercepting sewer, with flat top, vertical sides and saucer bottom with areas equivalent to 42-in. and 36-in. circles. A portion of each size was on piling.

2. The first two 36-in. sewers above mentioned were built of concrete as experiments to find if our local conditions were favorable to that construction. Up to the present time no fault has been found with them. The other sewers mentioned were reinforced concrete, as they lie so close to the surface of the ground that lack of head room forced us, not unwillingly, to adopt that construction.

3. We have some concrete pipe sewers in use, that were laid over 40 yrs. ago. Some have been replaced by vitrified pipe and brick. The sizes run from 12-in. to 24-in. They have worn rough on the bottom and a considerable portion of the larger sizes (oval) have split, but not badly enough to necessitate relaying. I wish that they were out and brick and vitrified pipe were in their places. These sewers were constructed far ahead of my time and I do not know the proportion of sand to cement in them, nor the kind of cement used. I do not think they should have consideration in discussing the concrete sewers of today.

We have no Portland cement concrete pipe sewers of modern type in use, so I have no criticism to make, based upon personal experience. The monolithic concrete sewers have proved satisfactory. They have not been in use long enough fully to show lasting qualities, but I have no apprehension of failure.

Our experience with brick and vitrified pipe has been so favorable that we are, perhaps, prejudiced. In the majority of cases, for large sizes, concrete sewers probably would cost less than brick sewers, as we build them. Concrete is used now in foundations and haunches and the former timber platform has gone by except for special conditions.

Leaving out the old concrete pipe sewers, we have the following concrete sewers in use: 0.341 mi. 36-in. concrete, 1.025 mi. 36-in. reinforced concrete, .432 mi. 42-in. reinforced concrete, .319 mi. 4-ft. x 6-ft. reinforced concrete double, .013 mi. 4-ft. x 6-ft. reinforced concrete, .018 mi. 4-ft. x 8-ft. reinforced concrete.

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[1] Lock Joint Pipe Co., N. Y. C.

[1] Described in Concrete, Nov., 1915, p. 174

The vitrified pipe with Y branches, even in large sizes, are so easily handled that we are strongly inclined to prefer them, admitting our lack of experience with other kinds. The slants are easily built into brick sewers.

We have been fortunate in having had unusually skillful brick masons and having been able to keep the work always under the supervision of capable, well paid inspectors. None of our vitrified pipe sewers shows wear and repairs have been comparatively small.

Some of the information asked for under "Quesions" is given in the answers under the other three divisions. The 4-ft. x 6-ft. twin sewer mentioned was built under 26 tracks of the N. Y., N. H. & H. R. R. From base of rail to top of sewer the distance varies from 2 to 4′. The sewer passes under one end of the station platform. No effect of the constant hammering is shown and but one shrinkage crack has been found.—H. J. Kellogg, Asst. City Engr.

NIAGARA FALLS, N. Y., BELIEVES CONCRETE BETTER TO RESIST ACID

Concrete sewers have been laid in this city since 1896. There exist 284′ of 26-in.; 786′ of 27-in.; 1,500′ of 32-in.; 1,039′ of 33-in.; 64′ of 48-in.; 2,890′ of 54-in.; 60′ of 60-in.

Concrete sewers were adopted because they were cheaper than brick and due to the acid contained in some parts of the city sewerage it was believed that concrete would last longer than brick; our expectations have been fulfilled.

The last three years lock joint sewer pipe has been used because of the ease of manufacture, thorough inspection before laying, and accuracy and ease in laying.—F. S. Parkhurst, Jr., City Engr.

OMAHA USES LITTLE CONCRETE

We have no concrete pipe sewers, and very little monolithic concrete sewer construction. — Watson Townsend, City Engr.

PORTLAND, OREGON, LAYS PRACTICALLY ALL CONCRETE SINCE 1909

1. Since 1909 practically all sewers in this city over 24″ have been constructed of concrete. Smaller sewers have been of vitrified pipe.

2. Concrete sewers are used because lower in cost and on account of the smooth interior surface. For sewers over 42″ our experience has been that monolithic concrete sewers are superior to reinforced concrete pipe, although the cost may in some instances be greater. —Philip H. Dater, City Engr.

OSHKOSH, WIS., SEWERS LAID IN '84 STILL GOOD

Oshkosh has over 50 mi. of concrete sewers. The first were laid here in 1884 and are still in good condition. Some poor pipe was laid about 1892 or 1894 and since then the vitrified pipe has been exclusively used until this year. We are now putting in both kinds of pipe and I believe the concrete pipe is the best for large sizes. If concrete pipes are properly made they are perfectly satisfactory to me. I know by experience that both concrete and clay pipe can be good, and that either may be poor. My experience on the whole has been that concrete pipe are superior to vitrified for pipe over 12″ in diam.—R. H. Randall, City Engr.

OSWEGO, N. Y., FINDS CONCRETE STRONGER AND MORE ADAPTABLE

1. Since 1894, 1,308.5′ of 6-ft. x 10-ft. 3-in. oval reinforced monolithic, 1,796′ of 72-in. pipe and 704′ of 66-in. pipe have been laid and at present we are laying 2,080′ of 60-in., 1,140′ of 36-in., 33-in., 30-in. and 24-in.

2. Greater strength, less liability of breakage. Manufactured at home.

3. Satisfied with both pipe and monolithic type.

4. Adaptability of concrete for various shapes and sizes of sewers. Smooth inverts at joints. Less joints to resist leakage to sewer.—J. F. Flanigan, City Engr.

GREATER STRENGTH, NO CRACKS, SAYS PITTSBURGH, KANS.

1. We use concrete for the larger storm sewers only. 1,852′ 72-in., 730′ 60-in., 395′ 48-in., 235′ 36-in. and 345′ 30-in.

2. Cheaper. Get greater strength and freedom from cracks because they can be reinforced.

3. Satisfied with monolithic. Have not used pipe. Have local clay pipe factory.—City Engr.

PITTSBURGH BUILDS MILLION DOLLARS WORTH OF CONCRETE SEWERS

1. Pittsburgh has constructed concrete sewers extensively since 1911. Before 1911 concrete was used on a few small jobs. Construction since 1911 has included concrete sewers to the extent of about $1,000,000, ,sizes ranging from 48″ to 9′, and including both plain and reinforced concrete construction. Concrete sewers have been constructed very largely to replace or supplement brick sewers which have become worn out and inadequate in capacity.

2. Reasons for adopting concrete construction in sewers are as follows: Economy in construction, greater structural been satisfactory in all respects. strength longer life.

3. Concrete sewer construction has been satisfactory in all respects.

4. Since steep grades predominate in Pittsburgh, we have deemed it necessary to line the inverts of our larger concrete sewers with vitrified brick, thus permitting relining in the future. This gives a smooth invert and simplifies construction. Theoretically, concrete has sufficient abrasive resistance, but results in the field are better assured by using the brick lining.

4. We have not as yet used concrete or reinforced concrete pipe, but consider that concrete pipe has a field for sewers in excess of 36″ in diameter and less than 5′. Below 36″ we use terra cotta pipe and in excess of 5′ the monolithic sewer is more satisfactory for local conditions. Charles M Reppert, Div. Engr

PLAINFIELD, N. J., USES SEVERAL TYPES

The first sewer in Plainfield was an egg-shaped, concrete pipe, storm sewer, constructed in the early '70's and now in use.

Several concrete sewers have been constructed in recent years, both for sanitary and for storm drainage, pipe, block and monolithic, rectangular and circular, plain and reinforced. At present a 42-in. monolithic, reinforced sanitary joint sewer is being constructed. The price of this sewer, 8′ to 10′ cut, is $3.50 per ft.—Andrew J. Cavett, St. Commr.

RICHMOND, VA., STILL PROTECTS CONCRETE

We have only a limited number of concrete sewers in the city of Richmond. Wherever we have used concrete, either plain or reinforced, we have invariably lined the invert with vitrified brick or tile, believing this to be a protection against the many acids, etc., which are admitted into our sewers.

So far as we have used concrete for sewers, plain or reinforced, they have given satisfaction.—Chatles E. Bolling, City Engr.

SALINA, KANS., FINDS CONCRETE BEST

1. We have one concrete sewer built in 1913 monolithic reinforced, size 36″.

2. Selected concrete on account of sandy soil, as we considered the monolithic concrete sewer would be best for this kind of trench.

3. The sewer gives satisfaction.

4. After we had built about 700′ of this 36-in. sewer 23-ft. excavation at $3.40 per lin. ft., the contractor prevailed on the Council to allow him to finish the balance of the work with vitrified pipe sewer at 70 cts. per lin. ft., as it was almost impossible to hold back the earth until the concrete sewer had been finished and set. Some of the pipe has shown longitudinal cracks, which are visible on top and bottom, and no doubt there is a crack in each of the two sides, there is very little displacement on the sides or bottom.

About 1 yr. after the concrete sewer had been laid it was found to be in good shape.—P. G. Wakenhut, City Engr.

SAN DIEGO, CAL., HAS FORTY MILES OF CONCRETE PIPE

We have approximately 40 miles of cement sewer pipe in use. About 18 mi. laid in 1910, 18 mi. laid in 1913, 4 mi. laid in 1914.

There seems to have been in the past a preference here for the vitrified pipe, owing to the fact that it was considered cheaper than the concrete pipe when the hauling and laying were figured. The question arose as to the durability of concrete pipe under the action of sewage acids.—George Cromwell, City Engr.

CONCRETE SEWER BUILT AT SOUTH BEND, IND., IN THE '80'S STILL IN GOOD CONDITION

1. The first concrete sewer constructed in South Bend was built of 24-in. x 30-in. hydraulic cement pipe; it is still in use, in good condition.

The second sewer was constructed in 1889 of pipe made of Portland cement. This sewer is about 2,200′ long, the size of the pipe being 10″, 12″ and 15″; it is still in service and shows no deterioration. We have since built about 3½ mi. of concrete sewers ranging in size from 72″ to 30″.

2. We have never adopted concrete to the exclusion of other material and the sewers that have been built were constructed in competition with other material.

3. To date we are satisfied with our concrete sewers and are now constructing about 3,000′ of reinforced concrete pipe.

All of our sewers are combined sanitary and storm water sewers.—Frederick J. Anderson, City Engr.

SPRINGFIELD, MASS., SAYS SATISFACTORY, LESS EXPENSIVE

1. We have used cement concrete for sewer work in this city since 1907.

2. We found that concrete sewers could be built for considerable less than the brick sewers laid prior to 1907 and we were of the opinion that concrete would give a smoother inside finish, resulting in a more sanitary condition and increased flow velocity.

3. We have continued the use of monolithic concrete, sewers for we have

found the material entirely satisfactory and less expensive than brick.—C. M. SLOCUM, Dep. City Engr.

STRATFORD, ONT., HAS TURNED TO CONCRETE PIPE

1. None in use.
2. A better sewer at less cost.
3. Yes.
4. Our main sewers being inadequate, investigations as to material, etc., were made, with the result that contracts were let and cement concrete tile made for this purpose during 1915. The 48-in. has 5-in. wall—.65 lbs. per sq. ft., reinforcing a 1:1½:3 mix—Lock Joint type. Price $2.85 per ft. This tile is now on the proposed pipe line but will not be in the trench until summer, 1916.—A. B. MANSON, City Engr., Stratford, Ont.

SUPERIOR, WIS.

3. Perfectly satisfied.

Note. We have not been using concrete for sewers except for large mains and monolithic reinforced construction.—E. B. BANKS, City Engr.

IRRESPONSIBLE PIPE MAKERS HURT AT TACOMA, WASH.

1. Began 1908—to date sanitary, 16.73 mi. storm, 19.3 mi.
2. To patronize home industry and reduce cost over vitrified pipe. Our faith in concrete pipe is not lost but we have had some very severe jolts.
3. Satisfied with pipe, if properly made. Small capital required, many irresponsible parties in the business.
4. The most interesting fact is the very good pipe and the very bad pipe, which look almost the same.—City Engr.

TORONTO, ONT., BUILDS EXTENSIVE CONCRETE SEWERS

1. In the construction of the trunk sewer in 1910-1911, concrete was used fairly extensively—some sewers monolithic with brick invert, other portions of concrete pipe. Since then we have constructed many large monolithic storm sewers. Some inverts were lined with brick, others were finished with concrete facing mixture. At the present time, where we have occasion to use concrete for sanitary sewers, we line them with a hard vitrified brick up to the springing line.
2. The principal reason for adopting concrete was to reduce the cost, and, in practically every instance, we have saved money.
3. Our concrete sewers have not been in operation long enough to express a definite opinion as to the service of same. When constructing sewers in tunnels through wet or treacherous ground, we find brick more desirable and economical.
4. The last few years, we have constructed many culvert shape sewers, with reinforced concrete tops because of the limited amount of head room; also some supported on trestle work. In these cases, we found that concrete was very beneficial, but provided against contingencies by putting in a brick lining on the invert.—R. C. HARRIS, Comm. of Wks.

TROY, N. Y., NOT BUILDING CONCRETE SEWERS

Permit me to say that this city does not maintain any concrete sewers. I do not believe that we will have use for this material in our sewers for three or four years.—A. E. ROCHE, City Engr.

THIRTY MILES OF TULSA, OKLA., SEWERS SATISFACTORY

1. We have been using concrete storm sewers—both pipe and monolithic for the last 10 yrs.; we have been using concrete pipe for sanitary sewers about 4 yrs. We probably have 30 mi. of concrete sanitary sewers; so far, they have given us very satisfactory service.
2. The principal reason was economy as the City Commission felt that there was a combination of vitrified pipe in this territory and therefore adopted concrete to decrease the price on pipe; the other consideration was the local advantage to labor since pipe is made locally.
3. Up to this time there has been no complaint.
4. Our concrete pipe is made by machinery. The inside of the pipe is glazed by a rotating drum therein during the process of manufacturing pipe. We have been securing a very high grade of concrete pipe.—T. C. HUGHES, City Engr.

WASHINGTON, IND., EXPECTS TO USE CONCRETE

Washington has had no experience with concrete sewers, but I have intended recommending concrete for a short sewer that the city is thinking of building in the near future.—HUGH F. O'NEALL.

WAUKESHA, WIS.

Main sewer concrete since 1889. O. K. still.'W. POWRIE, City Engr.

WILMINGTON, DEL., SAYS "QUALITY"

1. Concrete pipe for 8 yrs. Monolithic sewer approximately 15 yrs.
2. Quality, combined with lower cost than brick.
3. Yes.—City Engr.

Design Methods In Concrete Construction—Arches With Fixed Ends

By A. M. WOLF, C. E.[1]

This concludes Mr. Wolf's article on Arches with Fixed Ends (in the series "Design Methods in Concrete Construction," begun in the Jan., 1915, issue). The first part of the present article appeared in the Oct., 1915, issue, the second part in the Dec., 1915, issue.

DESIGN OF ABUTMENT

In view of the fact that for fixed end arches it is assumed that the abutments are unyielding, it is incumbent upon the engineer to design the abutments so that this assumption will be fulfilled as nearly as possible, for unless it is, the stability of the structure is questionable.

For the design of abutments it is necessary that some tentative dimensions be first assumed with the aid of the empirical formulas given in Part I, page 141, of the Oct. 1915, issue, and the allowable bearing on the soil upon which the abutment is to rest. Then the magnitude and the point of application of the forces acting upon the abutment must be found and the line of resultant pressure established. If the abutment as assumed does not meet the requirements as hereinafter stated its shape must be revised and the process repeated until all requirements are satisfied.

The external forces acting on an ordinary abutment are: (a) the thrust of the arch (b) the lateral earth pressure back of the abutment (c) the weight of the abutment masonry and (d) the weight of the earth and the live load above the abutment; the live load, however, is usually not considered since by so doing the action of forces is most unfavorable.

Of these forces the last two have a vertical line of action and produce only direct bearing on the soil; the first two, however, produce lateral thrusts on the abutment which tend to slide it on its base, and to overturn it.

Then, to make the abutment stable, the resultant of all forces must lie within the middle third of the base in order that overturning does not tend to take place; the product of the components of forces acting normal to the base and the coefficient of friction between the concrete and the foundation should in general be twice as large as the lateral thrust in order to prevent sliding, and the unit pressure on the foundation should be low enough so that no settlement will take place, which would at once alter the line of application of forces and perhaps change the stability as regards overturning and sliding and otherwise damage the arch ring.

The arch thrust is greatest when the live load extends over the entire span and the thrust for this condition of loading should be used in the investigation of the abutment.

The abutment should also be stable under dead load thrust and weight of abutment alone, without any assistance from the earth fill back of or above it, since this condition must be met during construction. The thrust for the half span opposite the abutment loaded, although less than for the case with full live load, may on account of its different line of application cause more uneven pressure on the foundation and this case should also be investigated.

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[1] Prin. Asst. Engr., Condron Co., Chicago

The general procedure for determining the line of pressure in the abutment graphically (Fig. 16) is as follows:

Determine the center of gravity and the weight of the abutment, prolong the lines of application of the arch thrust (for the particular loading giving most unfavorable thrust) and abutment weight to an intersection; from this point to any convenient scale lay off the respective pressures and by a triangle of forces determine the resultant force (the hypothenuse of the triangle.) In a similar manner determine the resultant of the lateral earth thrust and the weight of superimposed earth; assume earth to weigh 100 lbs. per cu. ft. and the lateral pressure of earth ⅓ of this amount. Prolong the line of this resultant until it intersects that previously found and by means of the triangle of forces determine the magnitude and line of application of the final resultant. Then scale the eccentricity of the resultant with respect to the center of base and determine the bearing pressures on the foundation with the aid of formulas (11 to 15 incl., see Oct. issue) which are applicable also to the case in hand. Since the bearing pressure will be uniform when the pressure line intersects the center of the base and becomes a maximum at one edge and approaches zero as the resultant approaches the edge of the middle third and since the former is the more desirable condition, the abutment should be designed so as to accomplish this as nearly as possible. By distributing the foundation pressure uniformly, uneven settlement will be avoided and the stability of the entire arch structure greatly increased.

If the base of the abutment footing is not placed perpendicular to the line of resultant pressure the component of the latter parallel to the base will tend to produce sliding of the abutment. In large arches the usual practice is to make the base perpendicular or nearly so to the maximum resultant pressure or to serrate (step off) the footing in such a manner as to produce the same result, the serrations aiding materially in resisting sliding. To protect against undermining the abutment face should be carried down for some distance into the permanent bed of the stream as a baffle wall.

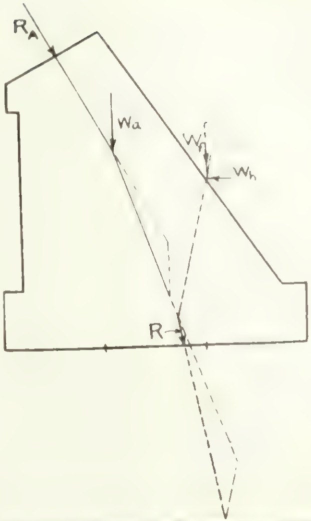

Fig. 16—Method of Determining Resultant Pressure in Abutment

For the sake of economy in materials in abutments the springing line of the arch should be as low as it possibly can be and at the same time give the desired clearance and waterway. It will often be found more economical to increase the span of the arch in order to obtain the required waterway or under clearance and maintain a relatively low springing line, rather than to raise the springing lines.

The more common or solid concrete abutment is here treated but conditions may be such as to warrant the use of the ribbed abutment where the foundation is rock or shale. This abutment consists of a number of heavy ribs extending back from a face wall connecting the ribs, from which the arch ring springs. Cellular abutments consisting of a number of box-like cells are a good type to use where the earth pressure is against the outside walls. The general principles involved in the design of these abutments are the same as those just noted, the detail design, however, being more complicated. Wing walls and the walls of cellular abutments are designed as retaining walls.

DESIGN OF PIERS

The piers of arch bridges are subjected to the horizontal thrust from the arch spans they support. If these thrusts are unequal the difference can be considered as a force acting at the top of the pier and tending to overturn it. Other forces acting on river piers are the river current and the ice pressure. The actual pressure due to current is not definitely known, the common assumption being a minimum of 150 lbs. per sq. ft. for flat surfaces subjected to freshets and 50 lbs. in tidal streams. These values are decreased by half for rounded end piers. The center of this pressure is assumed as acting at one-third the distance from the water surface to the river bed. The common assumption for ice pressure on piers is 48,000 lbs. per lin. ft. of pier width acting at the high water mark, for when the stream is in this condition ice fields exert their greatest pressure. Wind pressure on piers can in general be neglected except for very high piers. In order to reduce the effect of current and ice pressure in the pier the upstream end should be made triangular or rounded so as to deflect ice and reduce the eddying caused by the current striking the pier.

An ordinary pier should be investigated for live load over one entire adjacent span and no load over the other. If the arches are unsymmetrical the larger should be considered as loaded in order that the most unbalanced condition be obtained. For this condition of loading the resultant of the thrust and the weight of pier should fall well within the middle third. (The operation of obtaining resultant pressure on foundation is the same as outlined for abutments.) To obtain the proper size of pier footing the resultant pressure for both spans loaded should be ascertained. The thrust due to temperature changes or rib-shortening need not be considered except for very different spans and where the large span has a relatively small rise. The current and the ice pressure act at right angles to the other forces and tend to produce sliding of the piers; the fact that the piers are rigidly held at the top by the arches precludes overturning.

As previously stated in Part I, abutment piers should be placed at the end of every third or fourth span, these to be so designed as to be stable with the series of arches on one side standing and the others removed. This requirement is for the purpose of limiting the extent of failure to three or four spans should one arch fail from some cause or other.

The stresses in piers and abutments should in general be limited to compressive stresses entirely, except of course where reinforced concrete is used, but even then the stability of the structure is decreased if tension exists in some parts, and it is therefore best to avoid it. The stresses in any section of a pier or abutment can be found by formulas 11 to 15 inclusive, after the resultant pressure and its point of application are found. If the resultant makes an angle of more than 60° with the base of the pier, sliding will not occur and if it lies well within the middle third for the various conditions of loading the pier is safe against overturning.

In order that the concrete shall not crush under load the stresses should be limited to a maximum of 450 lbs. per sq. in. for plain concrete of a 1:2:4 mixture and 350 lbs. per sq. in. for a 1:3:6 mixture.

Where the adjacent spans are not the same, the pressure on the foundations can be made uniform by increasing the projection of footing course or courses on the side adjacent to the shorter span, thereby counteracting or balancing the effect of unequal thrust. In such piers it is well to provide some vertical reinforcement in the faces of the pier to take care of any possible bending stresses. By raising the springing line of the short span above the level of that for the long span the same result may be attained.

SPANDREL DESIGN

For earth-filled spandrel arches the spandrel walls are usually designed as gravity retaining walls ring to prevent sliding. Expansion joints are usually provided in such walls at the crown and over piers, and intermediate if spans are long, to prevent unsightly cracks from forming in the spandrels when the arch ring rises and falls, due to temperature changes. The spandrel walls should not be built until the arch centers have been struck and the arch has taken its initial deflection for its own dead load. Reinforced spandrel walls are used to some extent in large bridges to lessen the dead load. All spandrel walls should be designed as retaining walls (See article by S. M. Cotten, in Aug., 1915, issue) with a surcharge corresponding to the assumed live load.

When transverse spandrel arch construction is used the transverse walls are designed to take the arch thrust of the small arches and the direct load as columns subjected to bending and direct stress (See article on Design of Columns by Jerome Cochran in the June, 1915, issue). The arches which are usually of short span are in general designed as plain concrete arches with some reinforcement placed near the intrados at center and in the top over the walls if the arches are comparatively flat to care for such moments as may develop.

Where girder, beam, slab and column construction is used for spandrels the former should be designed in accordance with the principles set forth in the "Design Method" articles in the Mar., 1915, and the Apr., 1915, issue and the columns in accordance with those set forth in the article in the June, 1915, issue. Expansion joints should be provided in the spandrel construction at or near the crown and also at the piers or abutments.

APPROXIMATE METHODS FOR SOLUTION OF THE HINGELESS ARCH

The Melan Method—The following method for the approximate solution of the fixed arch abstracted from that given by Melan in *Plain and Reinforced Concrete Arches*, translated by Prof. D. B. Steinman, is of value for checking more exact designs and existing structures whose ratio of rise to span is less than 1/10 or 1/8, whose form does not depart very much from the parabolic or whose cross-section does not increase greatly toward the ends of the span.

Assuming that the arch is approximately a parabolic and that the term $I\cos.\Phi = I_o$, is a constant for full uniform live load the rise of the line of resistance equals

$$r' = r_o\left(1 + \frac{45}{4} \times \frac{I_o}{A_o r_o^2}\right) \quad (35)$$

where r_o = rise of arch axis and A_o = average cross-sectional area of the arch rib.

Now if the vertical projection of the moment of inertia of the cross-section $= I_o$, is constant, the algebraic sum of the area included between the arch axis and the resistance line must be zero, and the latter must therefore lie at a distance

$$\frac{1}{3}(r'-r_o) = \frac{15\,I_o}{4\,A_o r_o} \quad (36)$$

above the crown and

$$\frac{2}{3}(r'-r_o) = \frac{15\,I_o}{2\,A_o r_o} \quad (37)$$

below the ends of the arch axis. If the arch be considered of homogeneous material and the depth at the crown is d the above values of the intercepts become $\frac{5}{16}\frac{d^2}{r_o}$ and $\frac{5}{8}\frac{d^2}{r_o}$ (See Fig. 17.) This position of the line of resistance is of course true for uniform loading only as for open spandrel arches and not for earth-filled spandrel arches. However, for flat earth-filled spandrel arches the method can be used to estimate the points through which the line of resistance must pass and then the arch can be treated as a three-hinged structure which is statically determinate if three points in the line of resistance are known.

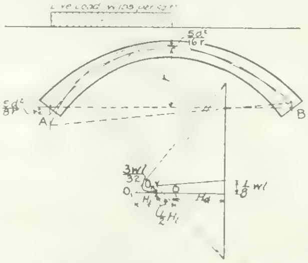

Fig. 17—Melan's Approximate Method of the Hingeless Arch

For the dead load only then the horizontal thrust

$$H_d = \frac{M_o}{r_o} \quad (38)$$

where M_o is the moment of vertical forces about the crown.

Having found the horizontal thrust for dead load only, the horizontal thrust for a uniform live load covering one-half the spans is given by the following equation.

$$H = H_d + \frac{1}{2}H_1 = H_d + \frac{1}{16}\frac{wl^2}{r'} \quad (39)$$

If the arch had hinged ends the vertical reaction at the right end *B* would be *1/8 wl*. However, owing to the fixity of the ends this reaction is reduced to *3/32 wl*.

In Fig. 17 to find the pole of the force polygon for live load on one-half span, increase the dead load thrust *Hd* by one-half the live load thrusts H_1 and correct for the vertical and reactions due to the live load; that is, raise the outer end of pole line for one-half live load and full dead load, $\frac{3}{32}$ *wl* and the inner end (at the load line) by *1/8 wl*. Thus in Fig. *17* the point *O* is the pole for the force polygon for dead load only, O_1 for full live and dead load and O_2 the corrected pole for dead load and live load over one-half span. Since the point of application of the line of resistance at the crown remains the same, the construction of said line is determined.

With full live load *w* per unit length the total horizontal thrust is

$$H = H_d + \frac{1}{8}\frac{wl^2}{r'}. \quad (40)$$

and the approximate moments are:

At crown,

$$M_o - \left(H_d + \frac{1}{8}\frac{wl^2}{r'}\right)\frac{1}{3}(r'-r_o) \quad (41)$$

At the ends,

$$M_1 = -\left(H_d + \frac{1}{8}\frac{wl^2}{r'}\right)\frac{2}{3}(r'-r_o) \quad (42)$$

For live load on one-half span the approximate moments are:

At end of loaded side

$$M = -\frac{1}{64}wl^2 - \left(H_d + \frac{1}{16}\frac{wl^2}{r'}\right)\frac{2}{3}(r' - r_0) \quad (43)$$

At the middle of the loaded side,

$$M = \frac{9}{1024}wl^2 \quad (44)$$

The Luten Method—The following is an outline of the method used in the design of earth-filled spandrel arches of the Luten type. The method is empirical, based on experience gained in the construction of a large number of such arches. These formulas are based on 350 lbs, per sq. in. compression in concrete, 50 lbs. shear in concrete and 15,000 lbs. per sq. in. tention in steel.

2. The inner curve of the arch is determined as follows (See Fig. 18). Draw an ellipse of the required span and rise, pass a segment of a circle through the crown and springing of ellipse, bisect the vertical distances between the ellipse and circle and approximate the resulting curve by arcs of circles, adjusting the curve at the springing to become tangent to the verticals. An ellipse is easily drawn as shown on the left of Fig. 18 by striking two concentric circles with the middle of the span as center and passing through crown and springing respectively; then draw any radius intersecting the two circles and project the points of intersection parallel to the span and to the rise, until they intersect in a point of the ellipse.

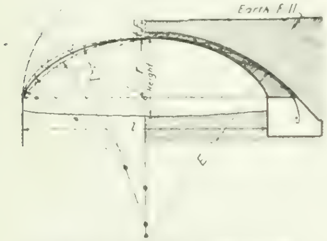

Fig. 18—Diagram for Determining Curve of Luten Arch

2. Lay off the crown thickness in accordance with the Luten formulas, Fig. 5, Part I, (Oct., 1915, issue.)

3. Draw the extradosal line of arch as a circle having a radius equal to Radius of Inner Curve at Crown

$$+ \frac{\textit{Crown Thickness}}{6}$$

Continue this circle to level of springings and then carry out on tangent.

4. Lay out the abutment with an area below the springing and adjacent the back tangent

$$\frac{4\ (2 \times \textit{Crown Thickness} - \textit{Height})}{\textit{Coeff. Friction}}$$

This formula gives correct results for a structure intended to be equally strong in all parts for short spans. However, the constant 4 in the crown formula results in a crown thickness desirable for practical reasons but excessive for the given loading and therefore when substituting in the formula just given the crown thickness may be reduced by 4.

The coefficient of friction varies with the material on which the abutment rests, ranging from zero for fluid foundations to unity for rock foundations, and therefore depends on local conditions.

5. The diameter of the bars required for reinforcing the arch ring are found by the formula

Dia. bars=square root of *Spacing* ×

$$\frac{\textit{Span} \times \textit{Conc. Load}}{\textit{250 Crown Thickness}}$$

The arch rods should cross the arch ring at one-third, one-half and two-thirds of the distance from springing to crown.

ARCHES WITH RIGID REINFORCEMENT TO SUPPORT PART OF THE DEAD LOAD DURING CONSTRUCTION

As has been stated several times previously in this article, the general practice in this country, as regards arch design, is so to proportion the arch rings or ribs that the resistance line remains within the middle third for all conditions of loading. Reinforcement is generally used in the arch, but since tensile stresses do not occur, or are very small, the steel cannot fulfill its proper function since the compression in the steel cannot exceed $n = 15$ (Ratio of moduli of elasticity of steel to concrete) times the allowable compression in the concrete which for 400 lbs. per sq. in. in the latter gives 6,000 lbs. per sq. in. in the steel.

It can readily be seen that if by some means an initial stress can be transferred to the steel before the concrete is capable of taking any stress whatever, this apparent waste of steel can in a measure be avoided. By the use of steel reinforcement of a rigid type so fabricated as to be self-supporting and at the same time capable of carrying a part of the weight of the arch concrete during construction, this end can be attained.

In the Melan system, previously described, such reinforcement is used. As stated in Melan's *Plain and Reinforced Concrete Arches* the centering is designed to carry a portion k generally ⅔ of the weight of concrete arch, the remainder $(1-k)$ being carried directly by the reinforcing ribs by suspending the forms from them. This weight produces a compressive stress f'_s in the ribs which, assuming the line of resistance for this loading coinciding with the arch axis is,

$$f_s = \frac{(1-k)wr_0}{a_0} \quad (45)$$

where w equals the weight of arch concrete per cu. ft. r_0 equals the radius of curvature of the axis at the crown and a_0 the ratio of the total reinforcement at the crown to the concrete section.

To this initial stress in the steel rib must be added the compression in steel caused by arch action $= f''_s = nf_c$ (or n times the concrete stress) then

$$f_s = f_s' + f_s'' = \frac{(1-k)wr_0}{a_0} + nf_c \quad (46)$$

transposing

$$a_0 = \frac{(1-k)wr_0}{f_s - nf_c} \quad (47)$$

In this construction the total stress in steel should be limited to from 10,000 lbs. to 12,500 lbs. per sq. in., since the initial stress should be kept comparatively low to avoid buckling of the ribs and excessive bending stresses. Where the ribs are secured, braced transversely at frequent intervals, this allowable stress can safely be increased to 16,000 lbs. per sq. in.

The modern tendencies in arch design are toward the most economical use of all materials involved in their construction and we can therefore expect to find reinforcement of the rigid type used to a much greater extent in future work.

Information Desired Regarding Effect of Vibration of Structures

Recognizing that practically every one is certain that higher speed, better work and greater human efficiency are possible in a stable building as compared with one that vibrates, but that exact data proving this fact are difficult to obtain, the Aberthaw Construction Co., Boston, is undertaking an exhaustive investigation in the effort to bring together conclusive evidence. The firm will greatly appreciate any suggestions or reports of experience that our readers may be able to send to them. These may have to do with any aspect of the case that will assist in the collection of facts or for reaching conclusions.

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Concrete Floor Construction For a Residence

THE QUESTIONS BELOW ARE DISCUSSED BY:

CHARLES H. NEAL[1]
A. MORGAN SMITH[2]
W. E. WAGNER[3]
PROF. A. B. MCDANIEL[4]

"What, in your estimation, is the most practical and economical floor design for the house plan shown, taking into consideration the following conditions:

"1. An isolated house which cannot stand investment in expensive equipment.

"2. Ordinary labor, an intelligent foreman, willing to follow directions but not a specialist in this class of work.

"3. Concrete material; bank gravel of good quality.

"4. Reinforcement; any type procurable in open market."

[EDITOR'S NOTE—The floor plan selected for discussion is that of a house described in the Jan., 1916, issue, p. 3, and built by J. F. Hahn, C. E.

This plan was selected because it involves distinctly different spans and because its size and arrangement would seem to make it of general interest.

No criticism of Mr. Hahn's design is implied; in fact, a design practically identical with that actually used was submitted by two correspondents, but it is omitted to avoid duplication.]

BY MR NEAL

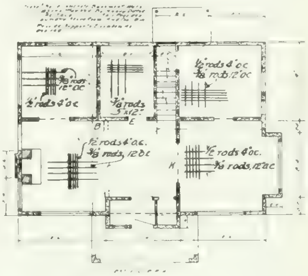

FIG. 1 FLOOR PLAN

If I were constructing the house in question I would put in simple slab floors 4″ thick of 1:2:4 concrete with ½-in. to ¾-in. top or wearing surface, 1 part cement to 2 parts good sand and treated with some one of the good dust preventatives on the market. If other than this finish were used I would probably make the base full 4″ thick, but in the case of the sand and cement finish would make it a part of the 4″, putting it on immediately after pouring the base, thus getting advantage of the strength in the compressive surface.

On the longer spans (13′ 8″) I would use ½-in. bars either square, deformed or twisted, spaced 4″; and ⅜-in. transverse bars spaced 12″. (See Fig. 1). I would support these bars ¾″ from the forms by means of spacing chairs or supports placed at every square foot crossing and wiring the ½-in. rods securely to the transverse rods. On the shorter spans ⅜-in. bars would be used altogether, spaced as above only when the span does not exceed 8′. Under 8′ I would space them 5″ instead of 4″. To get a good safe job the spacing chairs or supports are indispensable, because they insure against getting the steel down on the forms, hold everything in its place and permit of rolling wheelbarrows on boards laid directly on the rods without risk of damage—especially where the pouring is rapidly done. The form would be made of a medium grade of t. and g. ⅞-in. boards supported on 2-in. x 4-in. joists spaced 2′ o. c. with uprights placed 4″ to 5′ apart. If the concrete is carefully placed this will give a nice overhead surface which will need no further treatment except to rub out the form marks and kalsomine or paint as desired. A good grade of bank or creek gravel with the larger pebbles taken out will be all right for such work, provided the proportion of sand is not exceeded.

This work should require no great amount of skilled labor. A foreman of average intelligence willing to follow instructions, could with a force of ordinary laborers do the work. The lumber in the forms, if taken down with care, could be used for both floors.

To some designers such a floor as this may appear unsafe but the writer has recently had experience in floor construction which leads him to believe otherwise. I have now under way a concrete dwelling in which such a floor has been used.

The floor spans are 16′. At first I began to cast about for a suitable floor slab design and, wishing to economize in floor thickness, began to wonder whether or not 4″ would be safe for that span. I could find no formulas or tables that would allow such a thing nor could I find any case in which 4″ had been used in so great a span. I decided to make a test. A slab section 1′ wide, 4″ thick and 16′ long was made. The only available bars at the time were ⅜-in. twisted. Three of these were put in the section. The piece was poured so that when the forms were taken out the ends would be resting on supports just 16″ apart. At the end of 14 das. the forms

[1] Highway Engr., Asheville, N. C.
[2] Archt., Mt. Lebanon, Pa.
[3] Engr., Toronto, Ont., Can.
[4] University of Illinois, Urbana, Ill.

were removed and all of the supports except those at the ends were taken out. The slab deflected of its own weight about 1¼″. Two men weighing 150 lbs. each walked to the center and stood. It deflected then to about 3″ in all but showed no signs of failure. It was then raised back to a level position and left 7 das. longer. At the end of 21 das. the props were again removed and this time four men weighing approximately 150 lbs. each were placed in the center. The deflection was about as before but still there was no sign of failure except a few hair cracks that appeared on the under side between the outer edges of the section and the outer bars, which were about 1½″ from the outer edges of the slab. I attributed this to there being no steel to prevent rupture at these points. I was, however, not entirely satisfied with the result and decided to stiffen my floors by running beams through the centers of the spans one way. This was done but since pouring and testing my floors I have decided that these beams were not really necessary and that if I had made my floors as described above they would have been sufficiently strong. That old test slab has been there all through the job, with everybody walking on it and jumping up and down at will. It springs like a hickory board, but so far we have not been able to break it down. It seems to improve with age and the deflection is less now than at the beginning.

By Mr. Smith

Concrete floor construction for residence is suggested as follows:

Cellar wall (see Fig. 1 for references;—To be 10″ or 12″ thick; 3 ⅝-in. twisted square bars to run full length of front and back walls just over window heads. Not necessary to reinforce partition. Note "End of Cellar Wall" and connect across with beam at "E."

First floor slab—To be 5″ thick and reinforced with ⅝-in. twisted square bars 24′ 9″ long, spaced 12″ o. c. Beam "B" to be 8″ deep with 3 ¾-in. rods. Beam "E" to be 8″ deep with 3 ⅝-in. rods. Near cellar stair opening place 3 ⅝-in. bars about 5′ long.

First story walls—3 ⅝-in. square twisted bars to run full length of front and back walls over window heads and below second floor slab. Run 3 ⅝-in. bars through center partition over door heads and through beam "E."

Second floor slab—Thickness of slab and steel same as for first floor slab. Beam "B" to have 3 ¾ in. bars.

Second story walls—Reinforcing similar to first story walls. Partition "K" should have 3 ⅝-in. bars within 18″ of the floor.

Seventy lbs. live load on floors allowed. Concrete to be mixed 1:2:4, cement, sand and gravel. Usually for an isolated job, where skill is scarce, it is best to use heavier bars and space farther apart.

By Mr. Wagner

As economy is a vital question in the design of a dwelling of the type under discussion, the aim should be to secure fireproof qualities, using as far as possible the ordinary building materials, which can be easily procured, and methods which have been adopted from experience.

Reliable men can be found in any locality for ordinary building work, but when new methods are introduced considerable expert superintendence is required, to be sure of satisfactory results.

It is very pleasing to the engineer or architect to have every piece entering into a structure incombustible, but outside of this, very little gain is achieved in substituting fireproof material at higher prices for combustible material, which from its position and nature does not under any circumstances act as a menace to the building. The aim should be rather to make fireproof all such parts as are in danger of catching fire or of spreading it, or which could in case of fire cause serious damage to the building or contents.

With these things in mind the first step in designing a floor for a concrete dwelling is to get away from wooden joists which are in the most favorable position for catching and spreading fire. A close hardwood floor, tongued and grooved, if separated from wooden joists, is fireproof for all practical purposes, for a fire could burn on the surface for a considerable time without igniting it.

Even the ordinary lath and plaster ceiling will be almost as free from danger of fire as more expensive channel and metal lath ceiling, provided it is properly isolated by being attached to fireproof joists.

The design which I advise for floors in a moderate priced concrete house is reinforced concrete joists, with wooden floors and ceiling of lath and plaster, or standard fiber board, combustible in themselves but practically safe from fire for the reason that there is no place for fire to get a start, and affording no great danger to the house or contents in the event of fire starting due to some extraordinary cause.

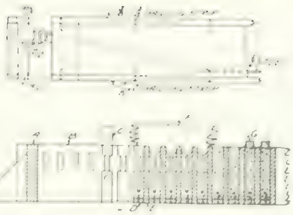

Fig. 2 Details of Form for Unit Joists

Concrete joists on 16-in. centers made and set as shown will cost in place, exclusive of the forms, about 95 cts., or about $15 more than wooden joists.

If a number of houses are to be constructed the cost of the forms for the joists will be slight, for they can be used repeatedly and hundreds of joists can be made with one set of forms.

The house shown in the illustration will require 54 joists 2″ x 10″ x 13′ 6″ reinforced with ½-in. steel rods with projecting hooked ends, and 54 joists of same dimensions 10′ 8″ long. The steel rods in these might be lighter, but it will be more convenient to use ½-in. steel for all.

The illustration shows part of typical joist with nailing strips attached and the method of manufacturing the joists and the forms necessary.

CONSTRUCTION

On a suitable level floor set up and brace as shown the dressed plank A 1¾″ x 11½″ and 1¾″ longer than the required length of joist. At right angles to this set up and brace end planks B of same dimensions, and of a length dependent on the number of joists it is desired to make in one set.

The end planks are slotted to admit of the passage of the bent ends of the reinforcing steel, and have cleats C nailed in place as shown, the section of cleat c′ being removable.

Having placed a bent rod through the slots of the end plank, raise it, and hold it in position with the removable piece of cleat c′. Next place the bottom nailing strip D in which are bent nails for bonding into the concrete, and attach the steel rod to the nails in several places with fine wire to hold it central. Now put the separating board E into the grooves formed by the cleats C. Every third or fourth nailing strip might be lightly toe-nailed to take the spring out of the lumber and keep all the joints tight.

After the steel and the forms for the required number of joists are in place and the outside plank set and braced, put in several spacing plank F to keep the separating boards to line until the concrete is partly poured. The concrete should be brought above the top of the forms and the surplus struck off with a straightedge.

Now place the top nailing strips G, through which nails have been driven and bent. On the outside form planks place gauge strips ¼″ thinner than the height of the nailing strips, and tap with several heavy straightedges until the straightedges rest on the gauge strips. If necessary, tack them down to hold the joists true to depth until the concrete hardens.

The lumber for forms should be soaked in water before using to prevent swelling, and should be well oiled.

Concrete should be mixed in the proportion of 1 of cement to 5 of uniformly graded gravel, passed through a ½-in. screen.

In erecting the joists, first have the forms for the side walls up to the level of the bottom of the joists, and nail a girt along the inside of the studs to support the joists. After the joists have been placed in position, with their ends projecting into the wall space continue the form work around the joists and pour the concrete, tying the ends of the joists into the wall, taking care to place steel rods over all openings to form beams of sufficient strength to carry the floors as well as the concrete wall above.

By Prof. McDaniel

In consideration of the best type of floor construction for a small residence, the principal factors are cheapness, strength, weight and ease of construction. The first two conditions, an isolated house and ordinary labor, will require simplicity in design and construction. This result can best be secured by the use of a flat slab with a type of reinforcement which can be easily and properly placed.

Two types of floor construction are adaptable to the conditions: the flat slab with a simple type of reinforcement and the one-way tile system. The latter type would be economical and light in weight, but the writer does not advise its use unless skilled labor is obtainable. Hence in this case, the writer would recommend a simple slab with a "mesh" type of reinforcement. Expanded metal unit high tensile wire fabric[1] or similar material such as rib metal,[2] is available, easy to place and efficient for light loads. This form of reinforcement should be placed with the long way of the mesh or the rib transverse to the supporting sides or parallel with the short dimension of the slab. In this case the clear span width of the living room , 13′ 2″, would govern the depth of slab, which could be made 5″ with the use of 0.35 sq. in. of reinforcement per ft. of width of slab. This design would be based on the use of a bending moment coefficient of $1/10$, assuming the slab to be fixed at the ends and continuous over the intermediate support. The illustration shows the method of placing the reinforcement. (Fig. 3.)

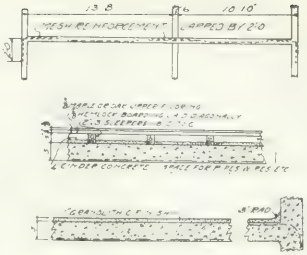

Fig. 3—Floor Details Suggested by Prof. McDaniel

It is assumed that the concrete would be mixed by hand or with a small batch mixer. The proportions should be about 1:2:4 by volume, although a simple density test might profitably be made to determine the proportions which would give the greatest density with the material on hand.

The concrete should be transported from the mixer to the floor in steel wheelbarrows and shoveled into place, care being taken that the reinforcement is entirely embedded.

The formwork could be simply provided for by a system composed of 3-in. x 4-in. posts spaced about 7′ o. c. through the middle of the larger rooms. The posts would support 3-in. x 6-in. girts, which would carry 2-in. x 6-in. joists spaced 24″ o. c., on which the 1-in. x 6-in. roofers would be laid. Along the outside walls the ends of the floor joists would be supported on ledgers. The slab forms might economically be made up into sections, about 3′ 6″ x 7′, which could be used at least twice to advantage.

Test Concrete Road and Bridge Slabs

The Office of Public Roads and Rural Engineering has begun a series of tests at Arlington, Va., to determine the proper thickness of the concrete base for roads of different types when subjected to loads of different magnitudes and when placed on various kinds of sub-base. In view of the increasing intensity of wheel loads to which roads are now being subjected, the solution of this problem is becoming of great economic importance. Steps have been taken to mold slabs of varying thicknesses on several kinds of sub-base and test them to destruction, the load being applied through various kinds of paving surface.

Concrete roads are now being built throughout the country with numerous kinds of aggregate and under various construction methods. There is a noticeable difference in the amount of wear suffered by these surfaces, and it is a much mooted question as to which kind of aggregate will prove most economical under particular conditions of traffic and location of source of supply.

In order to gain information of value in this connection, an instrument has been devised and constructed in the concrete laboratory at Arlington, Va., for the purpose of measuring the amount of wear of concrete roads of different types. Periodical wear measurements will be taken of concrete road surfaces on which the traffic conditions are known.

It has long been known that concrete is not elastic, but attains permanent deformation under working loads. During the course of a series of tests on reinforced concrete slabs recently made by the Office of Public Roads and Rural Engineering, and now being continued, it was very forcibly brought to the notice of the observers that the concrete continued to deform slowly as long as the load was applied. This fact is significant, as it helps to explain certain stress conditions in concrete roads and bridges when subjected to temperature changes. In order to study this phenomenon more fully, a series of tests has been begun to determine the "flow" of concrete and reinforced concrete when subjected to direct compression and to bending stresses. Working conditions will be maintained on the specimens as long as they exhibit "flow," and finally the specimens will be broken in comparison with like specimens that have not been previously loaded.

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[1] Am. Steel and Wire Co., Chicago, or Clinton Wire Cloth Co., Clinton, Mass.

[2] Trussed Concrete Steel Co., Youngstown, Ohio

Correspondence: A Department in Which the *Reader* Becomes the *Writer*

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow."

Concrete Pipe for Sewers—Clay Man Objects

In the letter which follows, from G. H. Tefft, secy.-treas. of the Intl. Clay Products Bureau, statements made by Charles E. Sims about concrete sewers are questioned by the representative of the clay pipe industry. Everyone desiring an impartial view in the controversy should read the letters from municipal engineers in the cities in which the use of concrete is under question. The attention of readers is also called to the letters elsewhere in this issue published under the title, "Is Concrete a Good Sewer Material?"

A LETTER FROM G. H. TEFFT[1]

The subjects of concrete pipe for sewers and its durability have not been treated so impartially in your correspondence department as their importance deserves. R. H. Hering, for instance, has very little to say on the subject, but after observing cases of the disintegration of concrete pipe by sewage in several cases in America and Europe his conclusions, as stated before the Am. Soc. of Civ. Engrs., were as follows:

1. When the immediate agent of destruction is carried by water disintegration will be found below the permanent water surface. If such water is flowing inside of a structure, as in a sewer (acid or alkali factory waste), the disintegration will be inside and as far as the water penetrates the material. If the water is ground water in alkali soil, swamp or peat, the disintegration will be on the outside (Great Falls and Osnabruck), chiefly between high and low ground water levels, and may penetrate porous material towards the inside of the structure.

2. When, on the other hand, the agent of destruction is caused by gases (generally sulphuretted hydrogen) arising from waters, whether on the outside (Osnabruck) or the inside (Los Angeles and Berlin) of a structure, the disintegration will take place above the permanent water surface.

Mr. Hatton, of Milwaukee, could give no information on the subject at all, yet the three men in charge of the field work of repairing Milwaukee's sewers, when interviewed by our representatives, all stated that concrete was not durable for this purpose; that it was affected in a few years by sewer gas, and they use nothing but clay pipe in making the necessary repairs. The advanced state of disintegration at the intersection of State and 16th Sts. agrees with their observations, and investigations by the Board of Public Works of Kansas City concerning concrete sewers in Milwaukee led to the same conclusion. They saw Portland cement concrete sewer pipes taken out of the ground in a state of collapse and disintegration.

Also in Mr. Sims's letter[2] there is a great deal left unsaid. He mentions San Francisco as a city in which concrete pipe has met with popularity. San Francisco engineers do not allow a foot of it to be used there. Monolithic sewers are sometimes used if lined with brick on the inverts. He mentions Oshkosh, Wis., without stating that the concrete sewer pipe there had been taken up in many places on account of being disintegrated. He mentions Chicago as having had no trouble with it. The only place we know of in which Chicago has used cement pipe such as he refers to was thus commented on by Chicago's chief sewer pipe inspector:

City of Chicago, Board of Local Imp.,
Chicago, Ill., May 9, 1913.
International Clay Products Bureau,
Kansas City, Mo.
Gentlemen:

In order to answer your inquiries about the old concrete sewer recently exposed at the site of the Transit House, Stock Yard district, in this city, I have inspected the site and find that the bare statement that the sewer has lasted 40 yrs. is entirely misleading. Although the bulk of the original material is still in place, it has apparently been for many years in a very disintegrated and unsanitary condition, carrying very little sewage and containing much deposited filth. The pipe, which seems to have been originally a good dense mixture of cement, sand and gravel, is now in such a condition that both the inner and the outer surface of pipe can be scratched off with the fingers so as to loosen the gravel. The entire section is saturated with and softened by sewage and all the pipes exposed are cracked longitudinally and across, allowing the sewage to soak into the surrounding ground.

In my opinion the sanitary condition of the neighborhood would have been improved if this sewer had not been allowed to remain so long, but had been rebuilt years ago.

(Signed) F. M. FINSWAITE,
Chief Sewer Pipe Inspector
of City of Chicago.

In San Diego there has been some concrete pipe used but Mr. Sims fails to state that the contractor who attempted to use it lost a great deal of money and was compelled to finish the contract with clay pipe in order to make the job according to specifications.

According to Mr. Sims's letter there are 400 mi. of concrete pipe in Brookline, Mass. This is not true.

There are 400 mi. of concrete pipe in Brooklyn, N. Y., but as soon as Engineer Fort got his specifications written so as to make a pipe that would pass, the people who made the concrete pipe went out of business.

According to Mr. Sims, Kansas City has used thousands of feet of cement pipe. In spite of the adverse report of their committee on public improvements who investigated the matter, the city did endeavor to use concrete pipe. Now the citizens whose property was taxed to pay for it have discovered that it is defective and have brought suit to prevent the use of their money for this payment.

We think that in this discussion the engineers have not spoken as fully as their knowledge would permit, and that the promoters of some special machine for making concrete pipe have, possibly, said more than is consistent with their knowledge of the subject.

EDITORIAL DISCUSSION

Mr. Tefft's next to last paragraph might convey the idea that

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[1] Secy.-Treas., Internat. Clay Products Bur., Kansas City, Mo.

[2] Letter from Charles E. Sims, this department, July, 1915, issue, under title, "The Popularity of Concrete Pipe is Increasing"

Kansas City having *endeavored* to use concrete pipe had now given up the attempt. And since we assume that Mr. Tefft's idea in writing *corrections* of the statements by Mr. Sims is none other than a desire to spread the truth, the whole truth and nothing but the truth, we are assisting Mr. Tefft where he has fallen short. We are presenting letters from city engineers and engineers in charge of sewers in those places specifically mentioned by Mr. Tefft. The engineer in charge of this department of public work received a letter from CONCRETE quoting what Mr. Sims said about concrete sewers in the city in question and also quoting Mr. Tefft's letter so far as it referred to the same city. CONCRETE asked the engineer this question: "Will you tell us the truth of this matter, with any side lights on the subject needed to form a correct understanding of the experience of your city with concrete sewers?"

Mr. Tefft quotes Rudolph Hering. The Editors wish merely to mention that this matter is published in full in the *Transactions, Am. Soc. C. E.*, Vol. 67, June, 1910, p. 572. This discussion by Mr. Hering is of a paper by George Gray Anderson on "The Effect of Alkali on Concrete." Attention is also directed to statements by Mr. Hering under the title "Cement Sewer Pipe," p. 37, Bulletin No. 19 of the Assn. of Am. Portland Cement Mfrs., entitled *The Use of Cement in Sewer Pipe and Drain Tile Construction.* The entire bulletin is worthy of consideration by the searcher for truth.

In the paragraphs from Mr. Hering's discussion quoted by Mr. Tefft, Mr. Hering *specifically refers* to the penetration of "porous material." This magazine has never recommended, nor has any intelligent advocate of the use of concrete in sewer construction ever recommended the use of a "porous material" which clear water would destroy, without any of the peculiar agents of sewage.

Mr. Tefft, it appears, lacks recent advice as to the trend of engineering opinion in Milwaukee. A letter from George F. Stall, city engr. of Milwaukee, in reference to Mr. Tefft's statements, is as follows:

CITY OF MILWAUKEE, OFFICE OF
CITY ENGINEER

Jan. 21, 1916.

This city's specifications permit the use of both concrete and vitrified pipe. In my opinion, concrete pipe made of proper aggregates and by modern methods will compare favorably with any kind of sewer pipe and is far superior to concrete pipe as made up to within the last few years. We have laid a large amount of concrete pipe since 1870 and the percentage of failures is very small and will likely be practically eliminated using the higher grade concrete pipe now manufactured. — (Signed) GEORGE F. STAAL, City Engr.

In reference to the situation in Oshkosh, Wis., mentioned by Mr. Tefft, there is the following from the city engr., G. H. Randall:

CITY OF OSHKOSH, WIS.

Jan. 20, 1916.

We have over 50 mi. of concrete sewers in our city and over 20 mi. of vitrified sewers. Our percentage of broken or defective sewers is about as follows: about 2 mi. of cement pipe has been relaid and about 2 mi. of vitrified pipe sewer is defective and is being relaid as it breaks down. Our concrete sewers that were laid over 25 yrs. ago or prior to 1890 are in good shape yet, and plumbers say they are perfectly sound today. Some of the concrete sewers manufactured about 1893-4-5-6 were poorly made and we stopped the company from manufacturing concrete pipe and have put in mostly vitrified pipe until last year, when we put in considerable concrete pipe. Concrete pipe properly made is a better pipe than vitrified for the sizes from 15″ up. Our old concrete pipe was made of a mixture of English Portland and Milwaukee cement with sand and lake gravel, and as English Portland cost about $3.50 a bbl. at that time, in 1885-1890, you may imagine what happened, but in spite of this the sewers of concrete pipe in the business districts are still in good condition, as the acids have not destroyed the pipe, as the clay workers claim. Most of our vitrified pipe sewers have been laid since 1899. At the present prices of Portland cement, concrete sewers can be laid that will be almost everlasting. With either material it is only a question of good pipe and good pipe can be made with cement or with clay.—(Signed) G. H. RANDALL, City Engr.

In reference to Chicago comes a letter from William Matthews, engr., Bur. of Sewers:

CITY OF CHICAGO
DEPT. OF PUBLIC WORKS
BUREAU OF SEWERS

Jan. 20, 1916.

In Chicago the sewers are of brick, tile pipe, plain concrete and a small amount of reinforced concrete. No cement (pipe) sewers have been built. It is therefore impossible for this Bureau to discuss the relative merits of tile sewer pipe and of "cement" sewer pipe, based on experience in the city of Chicago. We have one entire system of plain concrete sewer (diameters from 10′ 6″ to 3′). This system has been in service for something over 5 yrs. and its condition, so far as is known, is excellent.

Of the "concrete" sewer exposed at the site of the Transit House, located in the grounds of the Union Stock Yards and Transit Co., I have little knowledge. This sewer was laid before the stock yards territory was annexed to the city of Chicago.—(Signed) WILLIAM MATTHEWS, Engr.

The editors regret a misstatement in Mr. Sims's letter as to Brookline, Mass. It would seem almost obvious that Brooklyn, N. Y., was meant. The chf. engr., Bur. of Sewers, Brooklyn, Edwin J. Fort, writes:

CITY OF NEW YORK
BOROUGH OF BROOKLYN
BUREAU OF SEWERS

Jan. 21, 1916.

I note Mr. Sims's and Mr. Tefft's statements in regard to cement concrete pipe sewers in Brooklyn. It is true that there are several hundred miles of concrete pipe in use in this Borough at this time. Practically all of this pipe was made years ago in accordance with methods then in vogue, and judged by present standards would now be classed as of poor quality.

When I became Chf. Engr. of Sewers about 10 yrs. ago I objected to some of the features of this pipe; my principal objection was in regard to the shape of the ends. They were so designed that it was not possible to make a proper joint. It was also too porous for use in sanitary sewers where ground water was present in any quantity. I therefore prepared specifications which it was required to meet. The manufacturer of this pipe, which had been used for so many years by the city of Brooklyn, practically without any specifications at all, felt outraged that an engineer should presume to make such requirements as were made in the specifications. He refused to go to the expense of changing his molds or any of his machinery, with the result that no concrete pipe has been used in this Borough for several years. '(Signed) EDWIN J. FORT, Chief Engr.

Many statements have been made about the situation in Kansas City. This letter, from H. F. Johnson, engr., sewer division, is illuminating:

BOARD OF PUBLIC WORKS
KANSAS CITY, MO.
DEPARTMENT OF ENGINEERING

Jan. 21, 1916.

Concrete pipe has been used here for something over three years and ever since its first use there has been a fight waged against it by the vitrified clay interests. Roughly speaking, I should say that there has been about 35 mi. of concrete pipe used here and it has proven quite satisfactory. I know of no suits having been brought by property owners to prevent payment for concrete pipe sewer construction. Such a suit has been filed which makes complaint of some monolithic concrete construction. This work was done by a contractor who, it is claimed, is interested in the Concrete Pipe Co., operating there.

I made an investigation of the sewer complained of and could find no serious fault with its construction. My conclusion was that the suit had been brought for the purpose of harassing the Concrete Pipe Co. and, if possible, to allow some property owners to escape paying their tax bills. The case has not yet come to trial.

About a year ago an article appeared in one of the Kansas City newspapers which caused the Concrete Pipe Co. to bring suit against the paper for libel. The same attorneys who handled the case for the newspaper were also employed in the other matter above mentioned. The libel suit was automatically dismissed upon the death of the editor of the paper. This gives you an idea of the situation here.

I might add further that *the entrance of concrete pipe into the field of competition here has resulted in an improved product of vitrified clay pipe.*[1] We test a sample of each 200′ of pipe laid, submitting both materials to the same hydraulic and compression tests. We have very few failures of sewers in either material. A few partial failures in pipe culverts have occurred, but I think these were, at least, partly due to improper laying.—(Signed) H. F. JOHNSON, Engr. —Sewer Division.

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[1] The italics are ours Editors

Organizations

American Concrete Institute, John M. Goodell, Acting Secretary, 1418 Walnut St., Philadelphia, Pa. Convention, Chicago, Feb. 14-17.

American Concrete Pipe Association, Secretary, E. S. Hanson, 538 S. Clark St., Chicago. Convention, Chicago, Feb. 17-18.

American Highway Association, Chas. P. Light, Field Secretary; Colorado Bldg., Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C. Convention, Pittsburgh, Feb. 28-Mar. 3.

Association of American Portland Cement Manufacturers (Portland Cement Association), J. P. Beck, Gen. Mgr., Bellevue Court Building, Philadelphia, Pa.

Cement Products Exhibition Co., 208 S. LaSalle St., Chicago, Ill.; Robt. F. Hall, Secy., Chicago Cement Show, Coliseum and First Infantry Armory, Feb. 12-19, 1916.

Mid West Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb. Convention, Omaha, Mar. 1-4, and Mid-West Cement Show, Feb. 29-Mar. 4, 1916.

Second National Conference on Concrete Road Building, J. P. Beck, Secy., 208 S. LaSalle St., Chicago. Chicago, Feb. 15-18, 1916.

American Concrete Institute

In connection with the announcement of a provisional program for the 12th annual convention of the Am. Concrete Inst., to be held at the Auditorium Hotel, Chicago, Feb. 14 to 17, the directors have prepared the program in such a way as to give the greatest possible freedom to members wishing to make a study of the exhibits in the Cement Show at the First Infantry Armory and Coliseum, and to attend the sessions of the second national conference on Concrete Road Building, which will meet at the Auditorium Hotel on Feb. 15 to 18, 1916; the meetings of the Assn. of Municipal Bldg. Inspectors at the same place, probably Feb. 14 and 15; and the meetings of the Am. Concrete Pipe Assn. about the same date.

President Wason has the further announcement in relation to the work of the Institute:

The directors of the Am. Concrete Inst. have prepared a program for the convention in Chicago Feb. 14 to 17, inclusive, which is expected to be very fruitful in important practical results. It is hardly necessary to say that, in spite of the long labors of the Joint Committee, the design of reinforced concrete buildings is not yet adequately standardized to secure safe structures at minimum costs. Our municipal building codes prevent this, to a considerable degree. So the Assn. of Municipal Bldg. Inspectors will meet with the Institute and discuss the wide discrepancy between the results of reliable tests of full-size columns and the requirements of city regulations, and also the differences among different regulations. The results of recent tests by the Institute's Committee on Reinforced Concrete throw a searching and clarifying light on this confused situation, which should be productive of highly desirable betterments in conditions. The program has also been devised to bring about a discussion of the status of flat-slab design, so as to help remove this source of present conflict.

The construction of concrete roads in 1915 has been widespread and active. This was due in no small degree to the fact that the Institute's revised standard specification for highways and pavements put construction of this type on the same standardized basis as its older competitors. Its advocates did not have to introduce a complete novelty. The results of the use of these specifications and the desirability of making changes in them will be one of the leading features of the convention.

The committee work of the Institute has been comprehensive and very successful heretofore, but a great deal remains to be done in municipal lines. One session of the convention will be devoted wholly to such topics and will lead, it is expected, to the organization of a number of much needed committees.

The sessions of the Institute's convention will be open to the public and everybody interested in widening the use of concrete and improving the methods of construction will be welcome. The Institute desires to help all such persons and to be aided in its work by them.

THE PROGRAM

Monday Morning, Feb. 14—Opening remarks of the President, Leonard C. Wason, Pres. of the Aberthaw Const. Co., Boston; "Concrete on the Massachusetts State Farm," Arthur J. Maynard, Supt. of Const., and Benjamin Baker; "Relining the Winston Tunnel, Chicago Great Western Railroad," Harold P. Brown, Consult. Engr., 120 Liberty St., N. Y. C.; "Swimming Pools," Edw. D. Boyer, Cement Expert, Atlas Portland Cement Co., N. Y. C.; "Durability of Concrete Pipe," J. H. Libberton, Asst. Engr., Univ. Portland Cement Co., Chicago; "Novel Features of Concrete Work on the New York Subway," Robert Ridgway, Engr. of Subway Const., and Ralph E. Goodwin, Jun. Engr., Public Service Comm., N. Y. C.; Report of Committee on Nomenclature, Chmn., Frank C. Wight, Mng. Editor, *Engineering News*, N. Y. C.

Monday Evening, Feb. 14—"Cost Accounting on Concrete Work," Sanford E. Thompson, Newton Highlands, Mass.; "Operation of the New York Workmen's Compensation Law to Date," Wm. C. Archer, Dep. Commr. in Chg. of Bur. of Workmen's Compensation, State Industrial Comm., N. Y. C.; "An Interpretation of the New Standard Contract Documents," H. L. Lewman, Pres. Natl. Assn. of Builders' Exchanges, Louisville, Ky.; Report of Committee on Insurance, Chmn., J. P. H. Perry, Contract Mgr., Turner Const. Co., N. Y. C.; Report of Committee on Building Block and Cement Products, Chmn., Robert F. Havlik, Mooseheart, Ill.

Tuesday Morning, Feb. 15.—Report of Committee on Reinforced Concrete and Building Laws, Chmn., E. J. Moore, Chf. Engr., Turner Const. Co., N. Y. C.; "Requirements of Building Codes for Columns," P. P. Furber, Resident Engr. with C. A. P. Turner, Chicago; "Design of Concrete Buildings," W. P. Anderson, Pres., Ferro-Concrete Const. Co., Cincinnati; "Construction of Flat-Slab Floors." The details of this paper are in the hands of a special committee, which will announce the author later.

Tuesday Evening, Feb. 15—"Genesis of Reinforced Concrete Construction," Prof. W. K. Hatt, Purdue University, Lafayette, Ind.; "A Further Discussion of the Steel Stresses in Flat-Slab Floors," Prof. H. T. Eddy, 916 S. E. Sixth St., Minneapolis, Minn.; "Design of Foundations for Reinforced Concrete Buildings," Robert W. Boyd, Consult. Engr., 105 W. 40th St., N. Y. C.; Report of Committee on Fireproofing, Chmn., Major John S. Sewell, Gantt's Quarry, Ala.; Report of Committee on Treatment of Concrete Surfaces, Chmn., Cloyd M. Chapman, Engr. of Tests, Westinghouse, Church, Kerr & Co., N. Y. C.

Wednesday Morning, Feb. 16—"Tests Showing Continued Deformation under Constant Load," Prof. A. H. Fuller and Prof. C. C. More, University of Washington, Seattle; "Influence of Temperature on the Strength of Concrete," Prof. A. B. McDaniel, University of Illinois, Urbana, Ill.; "Tests of Reinforced Concrete," Burtis S. Brown, Consult. Engr., Boston; Report of Committee on Reinforced Concrete Highway Bridges and Culverts, Chmn., C. B. McCullough, Designing Engr., Iowa Highway Comm., Ames; Report of Committee on Sidewalks and Floors, Chmn., Lewis R. Ferguson, Engr., The Cement Assn., Philadelphia; Business Affairs of Am. Concrete Inst.

Wednesday Afternoon, Feb. 16—"Difficult Foundation Work on the Bay of Fundy," N. M. Looney, Chf. Engr., American Can Co., N. Y. C.; "Forms for Concrete Work," R. A. Sherwin, Resident Engr., Aberthaw Const. Co., New Haven, Conn.; "Concrete Viaducts," Frank L. Raschig, Principal Asst. Engr., Division of Structures, Dept. of Public Service, Cincinnati; "Construction of the Large Concrete Viaducts on the Lackawanna R. R.," C. W. Simpson, Resident Engr., Lackawanna R. R., Columbia, N. J.; "Tests of Large Concrete Slabs by U. S. Office of Public Roads and Rural Engineering," Earl B. Smith, Assoc. Mech. Engr., Office of Public Roads, Washington; Report of Committee on Reinforced Concrete Chimneys, Chmn., Harrison W. Latta, Engr., The Cement Assn., Philadelphia.

Wednesday Evening, Feb. 16—Report of Committe on Concrete Roads and Pavements, Chmn., A. N. Johnson, Washington, D. C.; "Concrete Foundations for Pavements for Heavy Travel," Clifford Richardson, Consult. Engr., N. Y. C.; "Essential Features for the Successful Construction of Concrete Highways," William M. Acheson, Division Engr., State Highway Dept., Syracuse, N. Y.; "The Construction of the Easton-Allentown Concrete Road," John T. Gephart, Jr., Division Engr., State Highway Comm., Allentown, Pa.; "The Construction of the Toronto-Hamilton Highway by Day Labor," H. S. Van Acoyoc, Chf. Engr., Toronto, Ont.; "The Construction of the Du Pont Concrete Boulevard," Charles Upham, Chf. Engr., Georgetown, Del.; "Special Features in Pavement," R. C. Stubbs, President R. C. Stubbs Co., Dallas, Tex.

Thursday Morning, Feb. 17—Report of of Committee on Concrete Aggregates, Chmn., Sanford E. Thompson, Newton Highlands, Mass.; "Tests of Concrete Materials at Cincinnati," Prof. G. M. Braune, University of Cincinnati; "The Chemistry of Portland Cement," George A. Rankin, Geophysical Laboratory, Carnegie Institute, Washington; "How Shall a Rational Specification for Gravel Concrete be Developed," C. C. Brown, Editor, *Municipal Engineering*, Indianapolis, Ind.; "Tests of Sands at the Structural Materials Research Laboratory," Duff A. Abram, Instructor in Charge of Laboratory, Lewis Institute, Chicago.

Thursday Afternoon, Feb. 17—"The Design of Plain and Reinforced Concrete Sewers," W. W. Horner, Engr. in Charge of Design of Sewerage and Paving, St. Louis, Mo.; "The Fall River Concrete Conduits," Frederic H. Fay, Consult. Engr., Boston, Mass.; "Concrete Construction at the Kensico Dam," Wilson Fitch Smith, Division Engr., Board of Water Supply, Valhalla, N. Y.; "Reconstruction of the Austin Dam," Lamar Lyndon, Consult. Engr., N. Y. C., and Frank S. Taylor, Const. Engr., Austin, Tex.; "Middleboro Water Tower," George Sampson, Consult. Engr., Boston.

Am. Concrete Pipe Assn. Convention

The convention of the Am. Concrete Pipe Assn., Auditorium Hotel, Chicago, Feb. 17 and 18, will have this program:

Thurs., Feb. 17, 2:00 p. m.—Registration; Opening of the Convention by the President, B. Blair, Woodstock, Ont.; Appointment of Committees; "Should Manufacturers Contract for Laying Their Pipe?", C. M. Wood, Chicago Portland Cement Co.; "My Experiences in Starting a Plant," R. F. Whale, Waupaca, Wis.; "Possibilities for the Use of Concrete Tile in the Mississippi Valley," C. H. Young, Pres., Central States Engrg. Co., Muscatine, Ia.; "Some Experiences in Promoting the Sale of Concrete Pipe," Will A. Curless, Mgr., Thomas-Hammond Machy. Co., Tacoma, Wn. At 6:30 p. m., annual dinner at Auditorium Hotel; address by Hon. A. O. Eberhart, former Governor of Minnesota. There will also be informal talks by others.

Fri., Feb. 18, 9:00 a. m.—"Advantages of Big Tile Over the Open Ditch," G. E. Warren, Universal Portland Cement Co.; "Developing the Use of Concrete Tile in Arid Districts," Lewis R. Ferguson, Asst. Secy., Assn. of Am. Portland Cement Mfrs.; "Recent Work of Committee C-6 of the American Society for Testing Materials," Geo. P. Dieckmann, Chf. Chem., N. W. States Portland Cement Co.; "Concrete Pipe Sewer Work in Salt Lake City," N. L. Morris, M'gr., Utah Concrete Pipe Co.; Report of Reorganization Committee. 2:00 p. m.—"Meeting Objections to Concrete Tile," F. S. Phipps, Chicago; "Reinforced Concrete Pipe," L. M. Stallard, St. Joseph, Mo.; "The Selling End," L. W. Pierson, Cement Products Co., Spencer, Ia.; Business Session.

Mid-West Cement Users' Assn.

The annual convention of the Mid-West Cement Users Assn. will be held at Hotel Rome, Omaha, Mar. 1, 2 and 3, 1916. Some of the papers that will be presented are:

Wednesday, Mar. 1—"Efficient Methods in the Manufacture and Cost of Cement Products;" "Concrete Construction Among the Indians," by Simon Redbird, supervisor of construction at the U. S. Indian school, Genoa, Neb.

Thursday, Mar. 2—"Permanent Farm Building Construction;" "Fire Insurance and Other Economies of Fireproof Houses," by F. L. Williamson, sales mgr. of the Dewey Portland Cement Co., Kansas City, Mo.; "Concrete Culverts and Bridges for Public Highways," by A. P. Young, Nebraska City, Neb.

Friday, Mar. 3—"Paving the Lincoln Highway," by J. B. Marcellus, Kansas City, Mo., engr., Assn. of Am. Portland Cement Mfrs.; "The A. B. C.'s of reinforced Concrete Construction," by W. A. Collings, Kansas City, Mo., C. E.

New Books

Concrete Silos—By E. S. Hanson, cloth, 5" x 8", 174 pp., illust., The Cement Era Pub. Co., Chicago. $1.00, prepaid.

This book has been prepared in response to a very definite need for a book which should present in condensed form, to the practical silo constructor, the knowledge available on concrete silos.

This book is frankly commercial; it recognizes that silo building is a business requiring the best of commercial equipment in order to be successful and profitable. The book does not, therefore, describe the construction of home-made apparatus nor does it cater to the farmer or to the tinkerer; it aims rather to put into the hands of contractors technical construction data and a concise but comprehensive statement of the value of silage and its proper use. The section on silage feeding is valuable, as it gives the contractor, in condensed form, material which will enable him to talk intelligently with prospects from their own viewpoint.

The requirements of a perfect silo are briefly discussed in a way that will provide valuable selling arguments. A series of letters from Agricultural Experiment Station experts is given in this section.

The construction data are specialized and include detailed studies of various types of reinforcement required for all sizes of silos. Tables and diagrams make this subject clear to the reader.

Considerable space is devoted to a discussion of available commercial equipment for building monolithic, block and stave silos. The brief description of each piece of equipment places emphasis on the points wherein it differs from other devices intended to accomplish similar results. The construction of the metal lath and plaster silo receives detailed treatment and some space is given to commercial silo accessories. One of the most valuable chapters is that dealing with selling methods, which gives information as to how business-bringing attention can be secured.

A 50-pp. catalog section is appended which is valuable for reference on modern silo equipment.

Economics of Contracting, Vol. II—By D. J. Hauer, cloth, 5½" x 8½", 334 pp., illust., pub. E. H., Baumgartner, Rand McNally Bldg., Chicago, $2.50.

To those who have read Vol. I of this work, the value of this book will be appreciated without introduction.

Volume II enlarges upon many subjects which were only briefly treated in the first book and adds many new subjects of vital interest to the contractor who would make a success of his profession.

The first two chapters deal with estimating methods, with the making of contracts and dealing with subcontractors and bondsmen.

Chapter three discusses the financial standing needed, and appreciates that in order to obtain profitable work it is often desirable that the engineer and the contractor promote the enterprise. The promotion of industrial and engineering projects naturally leads to the financial relations necessary; and to buying methods, making the best use of capital, which are discussed in a most instructive way.

Chapter four deals with the legal precautions and relations necessary to safe conduct of the business. The difficult subject of planning construction jobs, including plant layout and discussing several typical jobs, is handled in a way that makes it of especial interest.

Chapter six devotes 60 pp. to the handling and training of men. It is evident that the author is master of his subject throughout the book, but his treatment of this chapter is exceptionally good; it discusses the different classes of labor, labor organizations' training of bosses and workmen, and does not hesitate to criticize severely abuses that have too often allowed the exploitation of men. The arrangement and conduct of construction camps and commissary are ably treated.

The discussion of the liquor evil as a foe to both employer and workmen and ways in which the "floater" and the "bum" can in many cases be handled so as to become valuable workers is of particular value to contractors doing work in remote sections where labor is unreliable and scarce.

Four chapters treat of office organization, filing systems, the organization and conduct of a construction company, specialization in various lines of contracting, contractors' organizations and the contractors' relation to the public, to the engineer, to officials, to merchants and manufacturers and other subjects.

Monolithic Concrete Culverts at Low Cost in New York State

The value of the concrete culvert as compared with other types in common use is unquestioned but the fact remains that concrete should be more universally used for this purpose. Ignorance of local highway officials as to economical construction methods is largely responsible for the use of less efficient materials.

Aside from the fact that certain forms of pipe often used are not durable, the pipe culvert seldom has sufficient area properly to take care of heavy rainfalls. Too small size often results in clogging and in washouts.

While in the hands of the efficient highway superintendent monolithic culverts can often be installed at moderate cost, with wood forms factory-made equipment has shown some remarkable economies.

Using commercial forms[1] remarkable savings have been effected in the state of New York, as shown by the town reports which are reproduced.

It will be noted that a 12-in. cast iron pipe culvert cost, according to the Chofel report, $26.00 without head walls. These undoubtedly brought the cost to $40.00. In the Hayes report mention is made of a concrete culvert, 24" x 28" x 24', with head walls, which cost $20.84 with head walls, using steel forms. See the illustration.

Report of Culvert Construction for the Year Ending Oct. 31, 1914, Town of Caledonia, County of Livingston, N. Y.

	Road		Kind	Length	Span	Height	Area, Sq. In.	COST Sand and Gravel Cost	Cement	Labor	Excavation and Fill	Total
1	McEntyre	Steel Forms Used	Concrete	24'	2'	18"	370.2	$ .75	$4.80	$10.50	$3.00	$18.95
2	De Noon		"	24'	2'	2'	586.2	.75	6.80	9.00	4.25	20.80
3	McKenzie		"	24'	2'	18"	370.2	.60	4.80	9.00	5.25	19.65
4	McEwen		"	24'	2'	2'	586.2	.75	6.80	9.00	5.25	21.80
5	McCukendale		"	24'	2'	2'	586.2	.75	7.20	9.00	5.25	22.20
6	Reed		"	24'	2'	18"	370.2	.60	6.40	9.00	5.25	21.25
7	Reed		"	24'	2'	18"	370.2	.60	6.40	9.00	5.25	21.25
8	McEntyre		Cast Iron	24'	1'	1'		Cast or Wrought Iron, $24. Labor $2, No Headwall				26.00

Average area concrete, 462.77 sq. in. Cost per ft., 86 cts.
Average area cast iron, 113.1 sq in. Cost per ft., $1.08.
Concrete culvert has *four* times the capacity of cast iron for 22 cts. less per ft.

(Signed) T. C. Hayes, Town Supt.

Report of Culvert Construction for the Year Ending Oct. 31, 1914, Town of Avon, County of Livingston, N. Y.

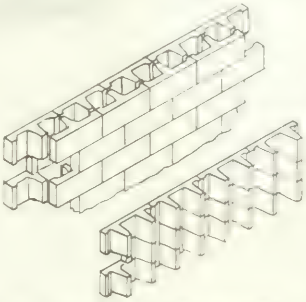
	Road	Kind	Length	Span	Height	COST Cast or Wrought Iron	Labor	Incidentals	Total
1	Agers	Iron	16'	10"	10"	$14.40	$4.00	$2.00	$20.40
2	Henty	"	16'	12"	12"	17.50	4.00	1.50	23.00
3	Littleville	"	20'	12"	12"	22.00	4.00	1.50	27.50
4	McKinney's	"	24'	12"	12"	21.60	4.00	1.50	27.10
5	Johnson	"	24'	12"	12"	26.40	4.00	1.50	31.90
6	Wheeler	"	24'	12"	12"	26.40	10.00	1.50	37.90
7	Thompson & Beckwith	"	20'	12"	12"	22.00	6.00	1.50	29.50
8	Littleville & Lights	"	24'	12"	12"	26.40	6.00	1.50	33.90
9	Pease	"	24'	10"	10"	21.60	8.00	2.00	31.60
10	Ward & Levine	"	24'	12"	12"	26.40	8.00	2.00	36.40
11	North Avon	"	26'	24"	24"	71.50	26.00	3.00	100.50
12	Gravel Hill	"	20'	12"	12"	22.00	6.00	1.50	29.50
18	Littleville & Lights	"	32'	12"	12"	35.20	6.00	2.00	43.20

Average cost per culvert, $36.33.
Average cost per ft., $1.60.
Total area of opening of culverts, 1,740.47 sq. in.
Average area of opening of culverts, 133.95 sq. in.

(Signed) Hervy M. Chofel, Town Supt.

One-Piece and Two-Piece Block Wall

Under the heading "Chicago Concrete Block House of Good Appearance," there was a sketch[1] (Fig. 1) purporting to show "two-piece and one-piece block construction,"[2] and the illustration was so absurd in its errors that they have undoubtedly been obvious. The draftsman confused one-piece and two-piece work and the editor permitted the error to pass. The accompanying illustration is what should have been shown before.



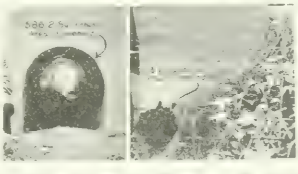
Detail Showing Two-Piece and One-Piece Block Construction

Operations in Making Wet-Cast Block to be Demonstrated at Cement Show

Further interesting evidence of the fact that the extensive exhibits of machinery at the Chicago Cement Show this year are to be supplemented by demonstrations in making actual concrete products, is contained in the announcement that there will be one space which on a small scale will show the actual operation of a system[1] of wet cast concrete block manufacture. Visitors at the show are familiar with the use of damp molding sand in various machines for making concrete products. The actual use of a concrete mixture will be more of a novelty. A mold car for making 30 wet-cast block will be used and this will be poured at a certain hour every day. There will also be a demonstration of just how facing aggregate is applied to face plates. On following days these block will be removed from the molds. Arrangements have been made for the removal and use by a Chicago customer of the block manufactured.

The old aqueduct built by the padres of the Ventura Mission in California is under investigation at the present time to determine whether or not the work that the old fathers did was or was not concrete. If it is decided that it is concrete, the experts who are doing the work claim that "it will be a comparatively easy matter to establish the fact that it is the oldest piece of concrete work in the U. S."

The much discussed concrete railroad tie again comes to the surface in the incorporation of a three million dollar company at Baltimore, Md., to manufacture, sell and deal in reinforced concrete cross-ties. The name of the company is the Maryland Metal Cross-tie Co. and its success will mean a great new field for concrete.



Comparison of Iron Pipe and Concrete Culverts

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[1] The Whalen Form Co., Syracuse, N. Y.

[1] Jan., 1916, issue, p. 20

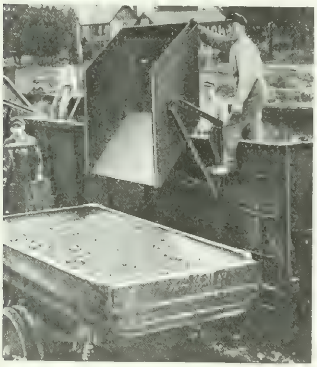
[2] Hydro-Stone, Barron & Harridge, Chicago

[1] Zagelmeyer Cast Stone Block Machy. Co., Bay City, Mich.

New Equipment, Methods and Materials:

New Tools with Which the Industry Works □ □

This magazine will not publish "reading notices," so-called, for the benefit of advertisers. These pages are edited for the Reader, as are all other pages in "Concrete." Manufacturers are constantly producing new and better methods and developing old methods, materials and machines. The progress of the concrete field is measured by the development of its tools. All developments along these lines are of real interest and importance to men who want to improve the quality of their work, decrease its cost, increase its quantity. This department is for just that kind of Editorial material. We, therefore, welcome detailed announcements which will be of practical value to Readers. Under no circumstances will this magazine publish any announcement simply because an advertiser asks it, nor refuse publication because a non-advertiser asks it. Material must carry information of real consequence to the reader. All material will be edited on that basis regardless of the source from which it comes.—**The Editors.**



The Lightning Unloader

A Car Unloader with New Features

The unloading of bulk materials from cars as often conducted wastes time. This is particularly true where motor vehicles are used, as the time taken to load them by shovelers seriously reduces their hauling capacity.

The Lightning unloader[1] was designed to eliminate this waste of time.

The device consists, as shown by the illustration, of a steel tilting hopper hung to outriggers which hook over the side of the car.

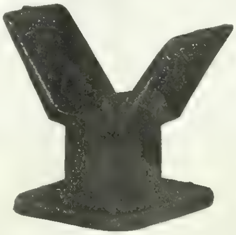
The hopper is filled by shovelers and as soon as the truck is driven under it is instantly tilted, discharging up to its capacity of 1½ yds.

A number of details are worthy of mention. The inside edge is curved up, which enables a full load to be retained. The hopper is mounted on cast steel trunnions, which are riveted to the body—a most substantial construction. The hopper is hung in slots so that it can be detached by simply lifting it off the supports. The outriggers are readily taken apart. The whole outfit can be carried by two men.

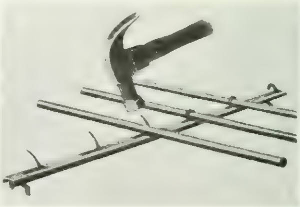
A Simple Concrete Insert

A device called the Unique Concrete Insert[1] has recently been placed on the market and is being specified in very large quantities because of its simplicity and consequent low cost. This device is intended for use where it is not necessary to secure adjustment and, as is well shown by the illustration, consists of a single casting arranged to be set on the forms and held in place by small nails through holes in its base. The shape of the insert insures a very firm anchorage.

The bolt hole is cored with a recess at the bottom and is tapped regularly for a ¾-in. bolt, the recess allowing a full-sized thread the entire depth of the bolt hole. The simplicity of this insert allows it to be used very freely and makes provision for all changes likely to occur.



The Unique Concrete Insert



Efficiency Spacing Bar, Showing Method of Securing Rod

Spacing Bar Insures Exact Placing of Reinforcement

The importance of accurate placing of the reinforcing is realized by every engineer and any device that will secure accuracy should be carefully considered.

A spacing bar[1] recently placed on the market consists of a light steel channel having tongues punched out of the web at specified spacing. A suitable chair is provided in connection with the spacing bar and it is only necessary to lay down spacers at convenient intervals and place the rods, when a tap of the hammer secures them accurately in position. Considerable time is saved in placing the reinforcing, which probably about offsets the cost of the material.

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[1] Heltzel Steel Form and Boiler Co., Warren, Ohio

[1] Medina Machine Co., Medina, Ohio

[1] Electric Welding Co., Pittsburgh

Five-foot Roadster Concrete Mixer Valuable on Country Roads

Experience is constantly pointing the way toward improvements in equipment for the concrete contractor. An interesting development is the so-called Roadster mixer,[1] which has been designed with a special reference to the needs of the rural contractor who must haul his equipment long distances over country roads.

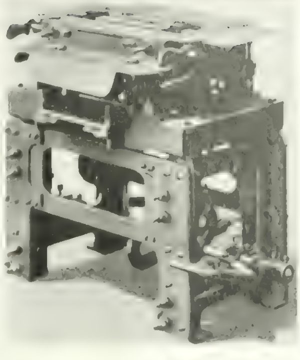
Lansing No. 5 Roadster

The principal feature of the new mixer is the high wheels, 24″ in front and 30″ in the rear, set to follow a wagon track. This mixer is equipped as desired with side loader of the open end type, holding platform, hoist, batch hopper, water tank and rotary pump, according to the requirements of the purchaser.

Dry Wall Block As Made in Cleveland

Concrete products manufacturers and others who remember the McIntyre block will see something familiar in the illustrations showing the machine for the manufacture of so-called Dry-Wall block.[2] The machinery and the units manufactured on it are being developed in Cleveland and in surrounding Ohio territory by Warren K. Rogers.

The original outstanding feature of this type of block is in the arrangement of air space. There is one complete air space so arranged that there is no straight line solid passage for moisture directly through the wall. There is another independent air space provided in such a way that, as the block are laid up, it can be filled with grout. The space provides for rods for horizontal and for vertical reinforcement, the rods to be surrounded by a wet mixture of concrete.



Machine for Making Dry-Wall Block

In the factory operated in Cleveland the machine works under automatic tampers, block being made vertically and delivered from the machine on pallets, thence to a car and into steam room, where block remain for from 24 hrs. to 36 hrs. to cure. Block which are to be used plain, as in foundations and for other ordinary work, are then run out into the yard to be kept wet for 10 das.

Block which are to be faced go through a special treatment which is rather unusual in block manufacture. They are removed from the curing room, wet on the face side, placed on their backs on little cars, which run on an inclined track by gravity in front of women operators who apply a facing mixture. This facing is in reality a stucco with exposed aggregate. They use a little frame just the size of the block which stands up about 3/8″ all around. This is filled with a facing mixture over the well wetted surface of the block. After the frame is filled with the special facing mixture which is a fine mix, coarse aggregates are spread on the top as desired and lightly tamped in with a block of wood. This operation takes from 3 min. to 4 min. per block. Most of the work is done by young women and as the block are finished they run on down the track on the little cars and are allowed to cure for 3 das. or 4 das. more. The faces of the block are then washed with an acid solution to remove surplus cement. Block then have further curing for a period of 10 das. The little frame used in applying the facing, hinged at the corners, clamps around the block by a simple operation. The block which are to be faced in this way are made with a rough surface on the face sides.

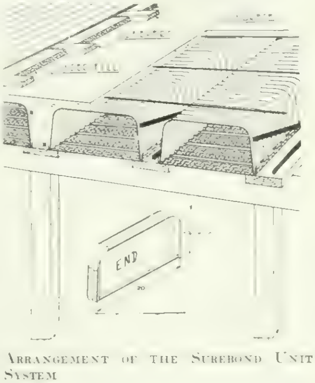
Block are made in 8-in. and 12-in. thickness, the cars used hold 32 12-in. block or 48 8-in. block and when these have been run into the curing room, 36 cars being in use, live steam is turned on into wells filled with water. A local company manufacturing block in Cleveland is The Dry Wall Co., controlling the County of Cuyahoga.

Another feature in the operation of the block machine is the fact that if a smooth tamped face is wanted the front compartment of the machine, that is, in front of the first air space, is filled with one mixture of concrete, while the back of the block is filled with another mixture. In this way the slower operations in applying a facing mixture which have already been described are not necessary. Mr. Rogers reports that at the Cleveland plant, using washed sand, and figuring steam curing, power, labor and everything that enters into a block make the block cost from 6 cts. to 7 cts. each, for 6-in. x 8-in. x 20-in. size, while the larger size block, 6″ high, 12″ thick and 20″ long costs about 3 cts. more. The additional cost for applying the coarse aggregate facing and including the cost of white cement used frequently with this facing, is from 4½ cts. to 5 cts. per block.

A New Non-Removable Floor Form

The use of light pressed steel forms on skeleton wood forms to secure beam and slab construction has become common.

What is known as the Surebond Unit System[1] employs a corrugated steel form to core the spaces between beams and also a perforated



Arrangement of the Surebond Unit System

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[1] Lansing Co., Lansing, Mich.

[2] Patent owned by the Blystone Mfg. Co., Cambridge Springs, Pa.

[1] The Goldsmith Metal Lath Co., Cincinnati, Ohio

bottom section which holds the upper sections in place and acts as a plaster base for the ceiling. The bottom section is stiffened by ribs of dovetail section which increase the mechanical bond of the plaster.

The illustration makes clear the arrangement and also shows the very simple form work used.

New Device Makes Concrete Step Building Easy

The construction of concrete steps is a detail which involves considerable skill and the waste of some lumber, because steps vary so much that it is seldom practicable to re-use material. A simple device used in connection with light channel iron bearers[1] is illustrated. It will be seen that provision is made for adjustment in all directions to cover the entire range of step building. A few minutes is enough to clamp the steel step holders into position and the riser boards which are held in place by spurs and dogs are readily placed. It will be noticed that the entire surface of the step is left entirely free of obstruction for finishing and that a substantial bearing for staging is provided.

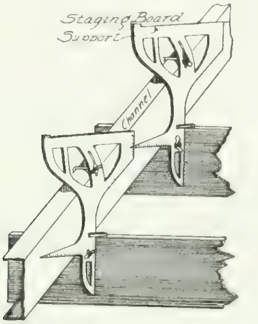

Fig. 1—Details of Steel Step Form

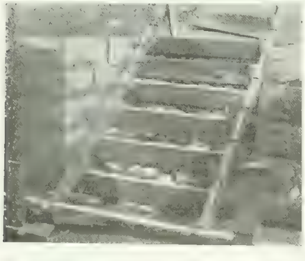

Fig. 2—Forms in Place Ready for Concrete

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[1] H. L. Park Co., Reading, Mass.

Trade Publications ☐

Anti-Hydro Waterproofing, Dampproofing—Anti-Hydro Waterproofing Co., Newark, N. J., paper, 8" x 6½", two colors, 8 pp. This pamphlet contains directions for the use of waterproofing, together with a discussion of its advantages and a list of users of this material.

The Wells Light—The Alex. Milburn Co., Baltimore, Md., 6" x 9", 12 pp., illust. This pamphlet describes and illustrates the Wells kerosene-burning light for contractors' use, also heating burners for use in shops and construction work.

Percoproof—The Philip Carey Co., Cincinnati, Ohio, paper, 4½" x 7", 16 pp., two colors, illust. A neat pocket-sized catalog describing the advantages of Percroproof dampproofing compounds in connection with concrete and general construction work.

Low-Down Concrete Mixer—Elite Mfg. Co., Ashland, Ohio, paper, 6" x 9", 20 pp., illust. An attractive catalog describing in detail the Elite continuous mixer, also gasoline pumping outfit, wheelbarrows and concrete carts.

A Chain of Evidence—Morse Chain Co., Ithaca, N. Y., paper, 6" x 9", 12 pp., illust. A well written and well printed catalog describing the Morse Silent Chain Drive. This type of drive is shown in use on a large number of typical installations and a table giving the data necessary for the design of the type of trassmission is included.

$500.00 a Month Making Reinforced Concrete Silos—Silo Equipment Co., Minneapolis, Minn., paper, 3½" x 6", 22 pp., illust. A neat pocket catalog describing a concrete silo building outfit, including forms, trucks, hoist and roof forms.

Current Prices — Concrete Materials ☐

Portland Cement—There has been practically no increase in cement prices during the past month. Prices given are f. o. b. cars at points named, including cloth sacks, for which, in general, 40 cts. per bbl. (4 sacks) is refunded on return in good condition. Prices per bbl. (including 4 cloth sacks) are as follows: Boston, $1.82; New York, $1.67; Chicago, $1.66 to $1.71; Pittsburgh, $1.71; Cleveland, $1.85; Cincinnati, $1.79; Detroit, $1.80; Indianapolis, $1.84; Toledo, $1.84; Milwuakee, $1.88; Minneapolis and St. Paul, $1.98; Duluth, $1.96; Peoria, $1.79; Cedar Rapids, $1.90; Davenport, $1.80; Denver, $1.87; Toronto, $1.75; Montreal, $2.00; Winnipeg, $2.60; Vancouver, $2.75; Spokane, $2.35; Seattle, $2.40; Portland, Ore., $2.40; Tacoma, $2.40; San Francisco, $1.90.

Crushed Stone—1½-in. stone, prices per cu. yd., f.o.b. cars in carload lots, unless otherwise specified. New York, 80 cts., in full cargo lots at the docks; Chicago, $1.00; Winnipeg, $2.50; Vancouver, $1.50; Spokane, $1.00; Portland, Ore., $1.15; Seattle, $1.50; San Francisco, $1.25.

Gravel—Prices given are per cu. yd. f.o.b. cars in carload lots unless otherwise noted. New York, 80 cts. in full cargo lots at docks; Chicago, $1.00; Winnipeg, $1.85; Vancouver, $1.25; Spokane, $1.00; Portland, Ore., 85 cts.; Seattle, 75 cts.; Tacoma, 75 cts.; San Francisco, $1.15.

Sand—Prices are per cu. yd. f. o. b. cars in carload lots unless otherwise indicated. New York, 45 cts., full cargo at docks; Chicago, $1.15; Winnipeg, $1.85; Vancouver, $1.00; Spokane, $1.00; Seattle, 75 cts.; Portland, Ore., 85 cts.; Tacoma, 75 cts.; San Francisco, $1.00.

Reinforcing Bars—The continued demand for large size bars for munition manufacture has materially increased the use of re-rolled bars and until the market becomes normal again a considerable amount of such material will no doubt be used. At the present time practically all business is being taken on a basis of $2.00 per cwt., Pittsburgh, with prevailing extras for bars under ¾" or base, and for delivery in 6 mos. to 7 mos., except in special cases. The following are quotations on base bars per 100 lbs., for mill shipments from other points, f. o. b. cars: New York, $2.169; Philadelphia, $2.159; Chicago, $2.189; Spokane, $2.85; Portland, Ore., $2.50; Seattle, $2.50; Tacoma, $2.50.

Shipments from stock are being made at the following prices per cwt. f. o. b. New York, $2.50; Buffalo, $2.45; Cincinnati, $2.50; Cleveland, $2.50; St. Louis, $2.45; Chicago, $2.40; Youngstown, $2.50; St. Paul, $2.30; Toronto, $2.50; Winnipeg, $2.45; Vancouver, $2.90; Spokane, $3.45; Portland, Ore., $3.15; Tacoma, $3.15; Seattle, $3.15.

Metal Clips for Supporting Bars—$4.50 to $6.50 per 1,000, depending on size.

For the majority of the prices given we are indebted to the Universal Portland Cement Co., Concrete Steel Co., Sandusky Portland Cement Co., American Sand & Gravel Co., Chicago, and F. T. Crowe & Co., Seattle, Portland, Spokane and Tacoma.

Reinforcing bars for mill shipments are in general sold on a Pittsburgh basis: that is, at the Pittsburgh quotation plus the freight to the point in question, and with the following list of freight rates on finished material and the Pittsburgh quotation given, the price of bars at any of the points listed can be readily computed.

From Pittsburgh, carloads, per 100 lbs. to:

Albany	16.9 cts.
New York	16.9 “
Philadelphia	15.9 “
Baltimore	15.4 “
Boston	18.9 “
Buffalo	11.6. “
Cleveland	10.5 “
Birmingham	45 “
Cincinnati	15.8 “
Chicago	18.9 “
Denver	68.6 “
St. Louis	23.6 “
New Orleans	30 “
Minneapolis	32.9 “
Indianapolis	17.9 “
Kansas City	43.6 “
Omaha	43.6 “
Pacific Coast Points (Rail)	73.9 “

Now that the Panama Canal has been opened to traffic ocean freight rates on reinforcing bars to Pacific Coast points have been established which materially lower the delivered cost of bars from the east. The rates per 100 lbs. to Pacific Coast points for large lots are. From Pittsburgh, 61.9 cts.; Chicago, 76.5 cts.; Youngstown, 61.9 cts.; New York, 40 cts.; Bethlehem, 52.9 cts.

Concrete

Vol. 8 *Detroit, March, 1916* *No. 3*

The Elimination of the "Dub"

ONE thing strongly in evidence at the Cement Show, at the Concrete Institute, at the Pipe Association meetings and at the Road Conference is that many influences are combining for the elimination of the "dub" from the concrete field. The haphazard worker, the unscrupulous worker, the unintelligent worker, and the contractor and manufacturer who are trying to do business on the small one-horse scale, are giving way before the field's necessity for intelligent service, careful workmanship, honest dealings and business methods. As long as concrete could be regarded in the field as a variety of mud without precise definition, as long as it was believed that concrete work was so simple that any laborer could do it, the industry was bound to be embarrassed by unsatisfactory results which discredited the efforts of intelligent contractors, engineers and manufacturers.

It is very noticeable now that manufacturers of equipment of various kinds for use in the concrete field are making no effort to sell to men who are not equipped either with sufficient training or with sufficient capital to enable them to carry their enterprises through to satisfactory conclusions. Manufacturers of equipment no longer want their machines and their systems of construction used by men not capable of making a success of them, running a risk, as they formerly did, of bringing discredit on their own machines and equipment through their abuse in incompetent hands.

In the concrete products field, in particular, in other days, it was common to induce any one who had the price of small equipment to go into business as a concrete products manufacturer. Much of the disfavor of concrete building units in some localities is due to this policy. It is strongly evident now that the producers of equipment intended for such use are becoming far less in number. Some of these producers are out of business as a result of such short-sightedness; others have learned their lesson and have seen the development of the industry and are making equipment intended for use in extensive enterprises by capable men. This was in evidence not in one case but in dozens of cases and manufacturers generally seem now to be convinced that their problem is not so much in selling equipment as in interesting able investors in what they have to offer, and in interesting men who give reasonable assurance that they have sound business principles and a desire and an ability to build up a business which will be a credit to them and to the producers of the equipment for many years to come.

The Concrete Mixer For 1916

A YEAR ago Concrete said editorially that the outstanding feature in mixer manufacture as suggested by the Show was the phenomenal development of the 5-ft. machine. It was pointed out that large contractors can use a number of small machines to replace one larger mixing unit on some big jobs and at the same time have available equipment for use on scattered small jobs.

This year there was no shortage of small mixers. In fact, nearly every mixer maker is taking care of the man who wants the small machine and evidence was presented that large numbers of the small sizes are being sold.

There is, however, to some extent, a reaction which indicates that the 10-ft. size, which is a compromise between the 5-ft. mixer and the very large machine and which obviates the necessity for bag splitting, is finding favor. This is particularly true with the larger contracting organizations who wish to secure flexibility without going to the other extreme and splitting the sack. Obviously the 5-ft. mixer will continue in favor on the smaller work and where extreme portability is desired.

More Time in the Mixing

IN some of the papers presented in the meetings of the American Concrete Institute and the Road Conference were indications of strong feeling that the mixing time has been cut excessively short in the desire to secure large output. It will be noted elsewhere in this magazine that the recommended practice of the Road Conference specifies a mixing time of one full minute in the drum regardless of the number of revolutions per minute. A paper by Mr. Simpson on the Tunkhannock Viaduct gives, as part of the specifications, the requirement that each batch shall be turned from 2 minutes to 2½ minutes while the mixer output on that important work was limited to 17 batches per hour. The same feeling is expressed by many engineers and contractors. It is believed that the longer mixing time is of especial value in connection with modern spouting methods and tends to secure a more homogeneous concrete and to prevent separation.

Drier Mixture for Paving

IF there was one factor in successful concrete paving that stood out above all others in the reports and in the discussions at the Conference on Concrete Road Building in Chicago last month, it is in the matter of consistency of the mixture. There was insistent emphasis from many quarters upon the fact that drier mixtures must be used than have been employed in the past on a large amount of road work. There seems to be no argument about the fact that a sloppy mixture does not give the best results and the problem of the field is largely in getting a ready delivery of a drier mixture from the mixer onto the road bed without encountering insubordination in the mixer crew which almost invariably likes to put a little more water in the mixture than belongs there because a wet mixture is more easily handled. At the Road Conference 2 years ago it was strongly pointed out that the best mixture for road work is viscous and pasty and the testimony on this score was even stronger at the recent meeting.

Second to the consistency of the mixture is the time of mixing. It is agreed quite generally that the concrete materials shall remain in the mixer drum for one full minute after the last of these materials has been placed in the drum, this length of time *not varying with the revolutions of the drum.* As the opinion is strongly expressed that while there should be at least 14 to 16 revolutions of the mixer drum, speeding the mixer in order to get this number of turns will not accomplish the result unless the mixing operation continues for *one full minute.* This decision has been arrived at after considerable investigation and the difference between the concrete mixed for three-fourths of a minute and the concrete mixed one full minute is told by the committee on Mixing and Placing.

The Portland Cement Association

WHILE the new organization of the Portland Cement Association is by no means completed there is even now strong evidence of activities in a promotional way which are almost sure in time to affect the entire concrete industry and the work of almost every individual in it.

Obviously the major consideration is the increase in the use of Portland cement, since the work of the Association along much broader and more intensive lines than has hitherto been undertaken is paid for by the member manufacturers of the Association. Since the Association is building for the future and not for a temporary increase in the use of Portland cement, its work will proceed upon the basis of good practice in concrete work and will endeavor to secure not only more concrete work but better concrete work. Details in various lines will be handled by bureaus of the association. Some of these have already been partly organized. The General Manager, J. P. Beck, will have a trained staff of men devoting their energies along special lines in the concrete field. It is particularly interesting to note that A. N. Johnson, one time State Highway Engineer of Illinois, and more recently road expert of the Bureau of Municipal Standards, New York City, becomes road expert for the Association. L. R. Ferguson will probably continue in charge of extension work of a technical nature. A. J. R. Curtis, formerly of the Universal Portland Cement Co., will devote particular attention to co-operation with educational institutions and for a time at least will continue along lines to which he has previously given particular attention in the agricultural field. C. M. Wood has become manager of a Concrete Products Bureau of the Association and proposes an active campaign in field work. H. Collin Campbell, formerly of the Universal Portland Cement Co., has the title of Editor for the Association. Several other bureaus it is understood will be formed and put in charge of able men. Practically all of these bureaus will have field men keeping in touch with important work under way and with important contracts about to be placed, with the idea of securing recognition for concrete work in various fields. In short, the activities of the Association as they have thus far been outlined promise to embrace not only service in the way of information but to embrace a great deal of field inspection work and promotional activities to increase the use of concrete in various kinds of construction with field men co-operating with manufacturers and contractors throughout the country. The Association is just moving into a very large suite of offices on the 15th floor of the Conway building, 111 Washington St., Chicago.

Concrete Silos — the Testimony of the Show

IF the Cement Show may be assumed to reflect the present status of the concrete silo business, several conclusions may be drawn. The increasing number of silo exhibits and the frequency with which concrete silos formed the topic of conversation, together with the enthusiasm manifested by many silo contractors, is evidence that concrete silo building is a firmly established field of contracting.

Monolithic silo construction was represented by a number of notable exhibits and it is apparent that concrete silo construction is attracting the attention of many of the larger contracting organizations who may be counted upon for first-class work. While this tendency seems strongest in connection with the monolithic structure, the unit silo is considered favorably by many as a substantial business.

Perhaps the most notable feature from a standpoint of novelty was the number of concrete silo staves on exhibition. This type of construction seems to be developing rapidly toward a more sound promotional basis. That the concrete silo stave seemingly has a number of strong points is conceded, but CONCRETE feels that a word of caution is timely. The apparent simplicity of the work and the small investment suggests the danger of a situation comparable to that following the introduction of the cheap block machine, the issue of which has thrown discredit that will be long in disappearing on the concrete block as a building unit. Those concerned in the future of the concrete stave silo should spare no pains to see that the business is placed in competent hands. Incompetency and carelessness will inevitably be followed by discredit, which will affect not only the concrete stave industry but, in a larger sense, the whole field of concrete silo construction.

The National Conference on Concrete Road Building actually conferred to a purpose.

The Chicago Cement Show As An Influence in Upbuilding the Industry

An Editorial

The success of an industrial exposition is measured by the impetus which it gives the industry it represents. The value of the Cement Show in the Coliseum and the First Regiment Armory in Chicago Feb. 12-19 will be written in terms of better concrete and more of it. The results will depend on the number of people and the kinds of people for whom the show means an awakened interest or an enlivened interest in the possibilities of concrete work, well done, in all kinds of construction.

It is one thing to show contractors a multitude of concrete mixers from among which to choose the machines for their season's work and it is another thing to show such products of the contracting and the manufacturing field of concrete as are most likely to create a general desire for more of that kind of work, thus creating activities for the contractors and the manufacturers who will require more concrete mixers and all other equipment with which to meet the demand.

It was with these things in mind in relation to the progress of the concrete field that this magazine published an editorial estimate of the Cement Show last year[1] intended to emphasize the advantage to the field which lies in the direction of showing to the visitors at the Exhibition not only the machines and the tools with which the industry works but some of the products of such equipment, in the belief that the inevitable result of showing to architects and to engineers and to the public at large the structural and architectural possibilities of concrete, which are not yet appreciated to their utmost, will be to create a larger and a more discriminating demand for the best applications of the material.

The material, concrete, has been a very satisfactory salesman in its own behalf, particularly in its structural application and in its demonstrated economy in permanent, fireproof, and weather-proof construction. The public is convinced of these values and yet in many instances has been reluctant to adopt a material which seemed to be limited in its possibilities for beauty in the nicer elements of architecture. The Feb., 1916, Cement Show was a most decided advance over the previous exhibitions in creating a new interest in the material for qualities which many visitors did not know it possessed. The management of the Show is to be congratulated on what it has achieved. That thousands of visitors were wide-eyed with gratification at what they saw should be sufficient incentive to follow still further another year along the lines already indicated in devoting quite as much attention to products of concrete and to definite demonstrations of the applications of concrete as to the tools and the machinery with which these things are made possible.

A MORE INFLUENTIAL SHOW

Manager Robert F. Hall and his able assistants really accomplished a great work this year in putting the Show into a new sphere of development where its influence for the upbuilding of the industry is bound to be much bigger and more fruitful. In justice, however, to the former manager of the Show, J. P. Beck, it should be said that the friendly and obviously constructive criticism of the former Show offered by this magazine in its Mar., 1915, issue was received by Mr. Beck with whole-hearted approval. In reference to this magazine's suggestions at that time Mr. Beck said: "Your estimate of the Show is a just one. We ought to have more exhibits showing the various uses and advantages of concrete." The time had evidently come when it was obvious not only to this magazine but to numerous others who have kept in close touch with the Show's development and its influence from year to year that there were opportunities for increasing that influence which had not been fully developed. It is to the credit of the present management of the Cement Products Exhibition Co. that it has been able to take up the work where a former management left off, with no break in the progress of its usefulness.

The Coliseum and the Annex which hitherto have held the entire Cement Show, this year were given over almost completely to machinery and equipment, while the Armory, connected with the Coliseum by a canvas-covered passageway, held many products of concrete, shown in such a way as to make a strong appeal to architects and builders and to the general public, always on the lookout for new mediums of architectural beauty.

The greater part of what this recent Show accomplished in the way of exhibiting the actual concrete products was accomplished through the joint exhibit made by about 25 cement manufacturing companies. A large space was devoted to factory-made concrete building units and there were examples of work from some of the most successful manufacturers of concrete stone in this country, so that visitors at the Show —and they were undoubtedly numerous—who have never known anything in the way of concrete building units but the most ordinary, unattractive block, could scarcely realize that the beautiful specimens of manufactured stone which they saw, really were properly described by the name of concrete. There was good variety of surface treatment, good variety in color and good variety in types of units. It is safe to say that if just a few of the patrons of each of the block manufacturers in this country could have attended the Chicago Cement Show so as to be led to demand of their manufacturers real architectural units of concrete such as were on exhibition there, it would require a few years only to eliminate from the field the objectionable examples of concrete building block. There were beautiful pieces of cut cast stone made of intimate mixtures of well graded, attractively colored aggregates and finished when cured just as natural stone is finished, by stone-cutters and carvers. Some of the work shown rivaled the very best of natural stone work, and according to many architects has qualities besides the advantage of lower price to recommend it in preference to natural stone.

There were concrete surfaces that had been washed and scrubbed while green, surfaces which had been acid-treated, surfaces given the fine parallel lines of tooling so prevalent in some of the best work in limestone; there were examples of color work in concrete, not only with colored mortar but with colored aggregate, inlaid tile and polished surfaces such as are common now only in terrazzo floors, where the colored aggregates are exposed, with beautiful results. This display cannot be said to represent expensive building units only, because there were excellent examples of beautiful work which is offered to the public at prices cheaper than those of brick.

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[1] Mar., 1915, issue

The joint exhibit also included a liberal display showing the application of concrete on the farm, with small models and blue print details of agricultural buildings and constructions of various kinds, including silos, cisterns and septic tanks. Fence posts of numerous approved types were on exhibition and there were men about to explain all these things to the visitors who did not fully understand them. There were also examples of surface finish and monolithic construction done with hand-operated polishing tools and rubbing tools, bush-hammers and brushes in addition to the more common stucco surfaces. Each piece of work demonstrated conclusively the architectural possibilities of concrete to sustain and popularize its structural values. A liberal space was devoted to concrete in road work, with samples of pavement slabs, models of bridge and culvert work and road construction. A bungalow big enough to be used as a part of the reception space for the cement company officers and employees was built of attractive concrete units and finished inside with a yellow, pleasing textured block. On the opposite side of the building was a quite elaborate building front of concrete units done in gray tones.

SOME COMMERCIAL FEATURES

The Armory also contained a number of individual exhibits of such a character as to be strongly supplementary to the effort made by the associated cement companies to show the applications of concrete. Several companies making ornamental concrete units had most interesting and pleasing displays. Sample walls, columns and garden ornaments were to be seen, and not the least interesting thing in the Armory was an exhibit of concrete roofing tile, which should go a long way toward establishing roofing tile, which has been one of the backward products of the industry.

The Armory exhibit of the agricultural applications of concrete was strongly supplemented in the Coliseum by unusual emphasis on the concrete silo. A number of the leading monolithic silo forms were exhibited; these received much attention from strong contracting organizations, not only as a farm structure but as a valuable storage unit for bulk materials, such as sand, coal and grain. The unit silo was represented by blocks and staves, the latter being shown in a number of exhibits. Special scaffold equipment for the erection of unit silos was a new feature.

The number of concrete mixers shown was probably greater than ever before but with the exception of the pavers, the mixers of large size were not much in evidence. Small mixers were there in great variety with a good number of the 10-ft. size. Attention is being given to increased speed in charging and delivery and to automatic water supply tanks, for it is becoming evident that extremely short mixing time is coming to be looked upon with disfavor.

A testing machine in the Armory created a great deal of interest. Daily tests of concrete were made and these appealed not only to contractors, in being absolutely convincing as to the relative value of clean materials and dirty materials, but to the general public, and the dial on the testing machine, showing the high pressure withstood by good concrete, must have gone a long way to make new friends for the material.

Another feature of this year's Show is the apparent development of interest in culverts of both monolithic and unit construction. With hundreds of thousands of dollars being spent for temporary construction of culverts in the roads of the U. S., the possibilities for the manufacturers of culvert units and for the contractor on monolithic culverts evidently appealed to many as a promising field. Not only were there interesting exhibits in this line at the Show but there was an apparent demand for information on this subject, indicating that contractors visiting the Show realized the opportunities that await an intelligent development of culverts to meet the increasing demand.

There was perhaps more than usual interest in burial vaults of concrete, since several systems of molds for their manufacture were available for investigation. The one thing most noticeable, perhaps, by its absence or at least by its unobtrusiveness was the small block machine, indicating quite conclusively to any close student of the field that the day of the "one-horse" block factory has gone by. There were several exhibitions of improvements in power machinery and in the more elaborate equipment used by concrete products manufacturers in making building units and several interesting tampers, but the block machine intended for backyard operation was absent. There were impressive exhibits of steel forms, gravel handling equipment and a steel tower and concrete spouting system.

INTELLIGENT APPEAL

Taken as a whole, the Show was one which appealed not to the "small fry" operator at all, but to the man who is entertaining ideas of developing a good business and a large business based upon sound methods, economical operation and big results.

While the shorter duration of the Show might in some measure account for the larger daily attendance which seemed evident throughout the greater part of each day, this feature is more than offset by the fact that the Show was scattered over two large buildings instead of being housed in one building alone, so that the crowd was scattered. For the most part the attendance was an intelligent one with a large percentage of business-minded men who came for ideas to put into their work.

Another year the management can make life more enjoyable for the visitors by enforcing the rule of alternate half-hours of quiet when the machinery is not operated. It seems possible that instead of making a ruling that machinery is to remain quiet for alternate half-hours and to cease running on the ringing of a gong some measure might be adopted so that all of the power for the machinery might be shut off at one controlling switch and thus effectually enforce the quiet in these half-hour periods as originally planned. Another year the management will undoubtedly find a way to go even further with the display of the products and the actual concrete work of the field, as an important supplement to the exhibition of the machinery. The two things rightfully belong together, and since as this magazine has already mentioned the Cement Show is a successful market-place for machinery, tools and raw materials, the exhihibition of the products of concrete can be relied upon to make the Show a more effective market-place.

Road Conference Considers 17 Committee Reports and Recommends Practice

The Second National Conference on Concrete Road Building, held at the Auditorium Hotel in Chicago, Feb. 15 to 18 inclusive, completely justified itself. Like the first of these Conferences, held two years ago, a large amount of business was handled in a short space of time and a quantity of detailed work was accomplished such as few conventions can boast. That there was a real demand for such a Conference was strongly evidenced by the attendance (total registration nearly 700) with an average of about 400 at each session. Chairman W. F. M. Goss and Secretary J. P. Beck and others who had the details in charge certainly deserve great credit for the service rendered the public in getting before engineers and contractors the best present-day thought on concrete road construction.

At the opening session on the afternoon of Feb. 15, W. F. M. Goss[1] made an address, "The National Conference on Concrete Road Building," in which he recalled the history of the organization, something of the work done by the First Conference 2 years ago, and outlined what the Conference hoped to do in its deliberations. Other addresses of general interest and considering mainly the subject of road building from the standpoint of the buying and using public were "The Increasing Public Interest in Road Improvements," by W. G. Edens[2]; "Building America's Highways," by Henry B. Joy[3]; "The Value of Permanent Highways for National Defense," by Major Amos A. Fries[4]; "Maintenance Bonds for Concrete Roads," by Edward Hoopes[5]. Addresses at other sessions of the conference were: "Motor Haulage and Good Roads," by S. M. Williams[6]; "Concrete Highways Subjected to Extremes of Temperature," by H. S. Van Scoyoc[7]; "The Development of Concrete Pavements in Southern Cities—Experience in Macon, Ga.," by J. J. Gaylord[8]; and "The Possibilities of Concrete Roads in Suburban and Rural Districts Near Large Cities," by Eugene W. Stern[9].

Seventeen committees presented reports on various phases of concrete road construction and while these reports represent the opinions merely of the members of the committees, since the reports were not subject to revision by the Conference, the reading of the reports in almost every case was followed by a most lively discussion, participated in by many of those in attendance.

Some of the high points of the Conference as affecting practice in road construction and representing the developments of the last two years in actual experience are, briefly, as follows:

The desirability of a much drier mixture of concrete than is commonly used in road construction, with insistence upon the point that there must not be an excess of water at the surface of the pavement, in order to get the best results.

There was emphasis on the desirability of more thorough mixing of the material, with mixing to continue for a minimum of one minute after all of the ingredients of the batch are in the drum of the mixer.

In general there was some apathy on the part of the engineers attending the Conference on the subject of reinforcing. The committee on reinforcing reports that all concrete roads should be reinforced. The Conference consented to the advice in practice set down by the committee on Resolutions to the effect that in general the use of reinforcement is justifiable. However, there was a most lively tendency to question the advisability of recommending reinforcing when there is an admitted lack of knowledge as to how the reinforcement should be placed, in what quantity it should be used, and as to its tendency to prevent cracks in concrete when it is used.

There was a tendency to eliminate from consideration in connection with the joints of concrete roads the metal protection plates which have commonly been used in the past to protect these joints.

There was a reinstatement of chutes in the good graces of road builders when properly used in the delivery of concrete from the mixer to the road bed. It will be recalled in this connection that a committee of the former Conference (1914) took a stand against the use of chutes in placing concrete, due to the fact that the use of the chutes made necessary so wet a mixture as to result in the segregation of the materials. It is to be noted, however, that neither in the recommended practice of 1914 nor in the revised recommended practice adopted at the recent Conference is there any choice between mixers of the two types. The preference for the boom and bucket in delivering concrete to the road bed was expressed two years ago in the report of the committee on mixing and placing materials, while the committee this year indicates a preference neither for one type nor the other, providing there are certain precautions in each case. For instance, in the use of the chute in delivering concrete the committee believes that the chute should have an incline of 20°, while in the use of buckets there is a slight indication of preference for the overturning type of bucket rather than the bottom-dump bucket in which it is said there has been some difficulty reported by a few contractors from stone or other pieces of aggregate sticking between the blades of the bucket and preventing closing the blades, with the result that the mushy part of the concrete contained in the bucket is lost before the greater portion of the batch is deposited. Given, however, the viscous and thoroughly mixed concrete which both Conferences have recommended there should be no separation of materials. The report of the committee as to bottom dumping buckets did not have further emphasis by the Conference as a whole. Conservative judgment is on the side of withholding any further verdict as to mixer performance on road work until thorough tests can be made of a battery of mixers of various types. This would afford a competitive demonstration which none of the investigating committees has yet had the advantage of.

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In addition to the recommended practice presented by the committee on Resolutions and adopted with slight revision by the Conference, the committee on Resolutions also presented as a part of its report resolutions expressing hearty appreciation of and thanks for the services rendered by the Chairman, Dr. W. F. M. Goss, and by the Secretary, J. P. Beck; to the presiding officers of various sessions and members of the Advisory Committee and the chairmen and members of the special committees, together with those who took part in discussions. Special thanks are also expressed for the assistance given by the Cements Products Exhibition Co. in defraying numerous expenses, including the publication of the proceedings.

Resolutions as adopted reiterated the statements of the previous Conference to the effect that it is highly desirable that the materials available in various states for use in concrete should be examined and tested as rapidly as possible by competent State Geologists, Universities or Engineering Experiment Stations and that the Governors and Legislatures of the states be provided with copies of the resolutions of the Conference and asked seriously to consider the great necessity for making adequate provision and appropriation to the proper agency for the prompt inauguration of such investigations.

In giving the proceedings of the Conference to the public special attention is called to the fact that the readers should be advised to read the Recommended Practice in order to get the views of the Conference, inasmuch as the Conference was not in every case in harmony with the views expressed in the reports of the various committees. The conclusions of the Conference embracing recommendations as to the field for concrete roads and the new recommended practice are as follows:

FIELD FOR CONCRETE ROADS

Owing to the increase of population the travel upon rural and suburban roads and city streets has incresaed rapidly in recent years, and this increase in travel, together with the introduction of the automobile, has necessitated the development of a new type of road surface Formerly macadam or broken stone roads were largely used, but the increase in amount of travel and the new conditions imposed by the automobile have made the cost of maintenance of such roads so excessive as to make them, in many cases, an economical impossibility. The concrete road is admirably adapted to meet these new conditions. Concrete roads are moderate in first cost, low in maintenance, smooth, hard, dustless, sanitary, easily cleaned and not slippery. They are suitable, first, for country highways where the road is subjected to overflow and on hills where storm water necessitates special gutter construction and where the macadam road surface may be washed away more rapidly than worn away; and, second, for pavements in small cities, for outlying streets of larger cities and especially for all streets where curbs are not required.

OUTLINE OF CONCLUSIONS

The salient features of the practice recommended by the Conference are:

1. Drainage of the road bed is vital.
2. Sub-grade must be of uniform density and should be compacted.
3. Aggregates must be clean, hard and tough.
4. Fine aggregates (sand) should be coarse and well graled.
5. A rich mixture must be used.
6. Materials must be accurately proportioned.
7. Mixing must be most thorough.
8. Sloppy concrete must not be used.
9. In general, the use of reinforcement is justifiable.
10. Inspection must be intelligent and thorough.
11. Concrete must be protected from rapid drying.
12. Pavements must not be opened to traffic too soon.

Newly Adopted "Recommended Practice" in Concrete Road Construction

RECOMMENDED PRACTICE

The Second National Conference on Concrete Road Building adopts the following principles as representing good practice in the construction of concrete roads and pavements:

1—MATERIALS

Portland Cement — Portland cement shall meet the requirements of the Standard Specifications for Portland cement of the Am. Soc. for Test. Mat. and tests should be made in accordance with the methods of tests outlined by the Am. Soc. of Civ. Engrs.

Aggregates—The selection of proper aggregates for concrete road construction is of utmost importance. Clean, hard, well graded materials are absolutely essential to success. For this reason samples of the materials proposed for use should be submitted to the engineer for approval before orders are placed. These samples should be carefully inspected; and, if possible, laboratory tests made to determine their suitability. If laboratory tests on shipments cannot be made, field tests can be used to furnish a general indication of quality.

The different aggregates should be kept clean and separate.

Aggregates to be used in the wearing course of two-course pavements should never be placed on the sub-grade but on planks or some other means provided to keep them free from dirt. When aggregates are placed directly on the subgrade care should be used by the shovelers to avoid getting clay or earth shoveled from the sub-grade into the mix. Aggregates should not only be clean when they are delivered on the job, but clean when placed in the mixer.

Water—Water supply is a most important factor and is frequently overlooked by the engineer and contractor. A large supply of water is necessary for (a) sprinkling the sub-grade; (b) mixing the concrete; and (c) keeping the concrete moist during early stages of hardening. For this latter purpose 25 gals. to 30 gals. per sq. yd. of pavement will be required in the summer months. Insufficient sprinkling is detrimental to the wearing qualities of the pavement.

Reinforcement—The use of reinforcement in concrete pavements is increasing. A coating of light rust will not be detrimental to satisfactory results but care should be exercised that no excessive rust, paint or other coatings are present to interfere with proper bond. Care should also be exercised to see that the reinforcement is so stored, prior to use, that it is not covered with mud or clay when placed in the pavement. Reinforcement left on a job when contract is completed at the end of the season should be collected and stored so that it is protected from the elyements. Occasional tensile and bending tests should be made to see that the requirements of the specifications are fulfilled.

Joint Filler—Joint filler should preferably be of a single thickness. Transverse joint filler should be cut to the crown of the pavement by the manufacturer when metal plates are used. A type of joint filler which will iron out readily under traffic is preferable for use in unprotected joints. A joint filler which will not bend easiy when concrete is deposited against it is to be preferred.

Joint Protection Plates—Metal joint-protection plates should be properly bundled and wired by the manufacturer so that they will arrive on the work in good condition, free from warp. Protection plates up to 20' should be shipped in single lengths. The exact length should be provided so that the contractor will not find it necessary to cut plates. In cutting plates for length, spacing between eccentrics on the installation bar should be considered to avoid interference with anchorage lugs on plates. Particular care should be used by the manufacturer in crowning the installing bar, to avoid the necessity of duplication of work by the contractor.

2—DRAINAGE

The drainage of the roadbed is of vital importance. If the sub-grade is not well drained, there is danger of unequal settlement or frost action, which will cause cracks. The method of drainage to be used will depend on local conditions. For roads proper drainage may be secured through lateral ditches. For streets, as well as roads, tile drains may be used which should be laid on each side of the roadway, or on one side only, with cross-drains leading thereto at a suitable depth, depending on the width of the pavement. Drainage trenches, if placed under the sub-grade, should be completed before final rolling.

3—GRADING

When roadways are constructed over fills extreme care should be observed to insure the use of proper materials in layers of such thickness that they may be thoroughly compacted so that when the fill is completed there will be a minimum of settlement. In general, fills should be made in thin layers, the depth depending on the character of material to be used in making the fill. The fill should be allowed to stand for as long a time as possible, giving it an opportunity to settle thoroughly before the pavement is placed thereon. Deep fills should be allowed to settle through one winter wherever such procedure is possible. Puddling will be found advantageous in compacting deep fills. Wetting and rolling should be performed when making a fill in order to secure thorough compactness. Fills should never be made with frozen materials nor with lumps greater than 6" in their greatest dimension.

4—SUB-GRADE

The fundamental requirement of the sub-grade is that it should be of uniform density so that it will not settle unevenly and cause cracks in the surface of the pavement. No part of the work is more worthy of intelligent care and painstaking labor than the preparation of the sub-grade. The slight additional cost necessary to insure good results is abundantly justifiable. When the pavement is constructed on virgin soil, care should be taken to remove all soft spots so as to insure a uniform density; and if constructed on an old roadbed, even greater care must be taken to secure uniform density, as the sub-grade is likely to be more compact in the center than at the sides. An old roadbed should be scarified, reshaped and rolled. The sub-grade adjacent to curbs should be hand tamped.

5—FORMS

Metal forms of sufficient strength to withstand the necessary hard usage are preferred. When wooden forms are used they should be of at least 2-in. stock and capped with a 2-in. angle iron, so constructed that adjacent sections can be lapped. Forms should have a width not less than the thickness of the pavement at the sides. Particular care should be exercised to see that the top edges of forms are clean so as to avoid unevenness in the finish pavement. If forms are warped or stakes not properly placed, a poor alignment of the edge of the concrete slab will result.

6—PAVEMENT SECTION

Thickness—The thickness of a concrete road or pavement is controlled by many factors, each of which should be given consideration. In view of the increasing use of the heavy motor truck and bus, it seems unwise to build pavements with a thickness of less than 6" at any point. In general, pavements shall be thicker at the center than at the sides. Alleys with an inverted crown and narrow one-slope roads should have a uniform thickness. Wherever the thickness can be increased without excessive cost, to secure a flat or nearly flat sub-grade, such increase is advisable.

Width—The desirable width for single-track road is 10'. The desirable width of double-track roads is 18'. The total width of the roadway should not be less than 20' for single-track roads and not less than 26' for double-track roads.

Crown—The crown of roads and pavements should be not less than $1/100$ nor more than $1/50$ of the total width. Except in unusual cases, $1/100$ will be sufficient for country roads and $1/50$ will be considered satisfactory for alley pavements. For city streets an average crown of $1/75$ will generally be found sufficient and should not be reduced, except on grades.

7—JOINTS

Transverse Joints—-Joints should be placed across the pavement perpendicular to the center line about 50' apart.

There seems to be a tendency to widen the distance between joints.

Joints should extend entirely through the pavement as well as through the curb if integral curbs are used. Joints should be constructed perpendicular to the surface of the pavement to avoid the possibility of one slab rising above the other.

Longitudinal Joints—Longitudinal joint filler should be staked or otherwise securely held against the curb. Joint material should also be placed around manholes, catch-basins, etc.

Protected Joints—The tendency of present practice is toward the omission of metal protection plates for joints. It is possible that the value of metal protection plates is dependent somewhat on the character of aggregate used, and it is considered that they are more essential in street pavements than in country highways.

Plates — Plates for protected joints should be wired together with the joint filler in place and securely held in the installing bars. When short sections of joint filler are used they should likewise be wired together. Supports for the joint should be used when the pavement is of such width that the installing bar deflects. On wide streets every joint should be checked as to crown with sighting T's. When necessary to have joint plates in two sections, the contractor should arrange with the manufacturer to have holes drilled in the abutting ends of the plates so that the plates may be securely wired or strapped together. As the joint plates usually do not fit tight to the installing bar, a ¼-in. shim is placed under each end of the installing bar, to insure that the plates are not covered by the concrete.

8—MIXING AND PLACING CONCRETE

Measuring—The method of measuring materials for the concrete, including water, should be one which will insure accurate proportions of each of the ingredients at all times. It is recommended that a sack of Portland cement, containing 94 lbs. net, be considered the equivalent to 1 cu. ft.

Proportioning—The proportions should not exceed 5 parts of fine and coarse aggregate, measured separately, to 1 part of Portland cement, and the fine aggregate should not exceed 40% of the mixture of fine and coarse aggregates.

Aggregates—Bank-run material shall not be used. Proportioning based on sieve analysis or by relative density tests is not practical for concrete roads except where laboratory direction is available; but where proper facilities are available the above proportions should be varied as the tests warrant.

Mixing—The ingredients should be mixed in a batch mixer of approved style, and the size of the batch should not exceed the rated capacity of the mixer. The mixing should be continued for at least 1 min. after all the materials are in the mixer and before any of the concrete is discharged. The speed of the mixer should not exceed 16 r. p. m.; however, the time and not number of revolutions should be the gauge of proper mixing.

Consistency—The tendency is to mix concrete entirely too wet. The consistency should be such as not to require tamping, but not so wet as to cause the separation of the mortar from the aggregate in handling and placing. The strength and wearing qualities of the concrete are vitally lessened by an excess of water in mixing.

Placing—If the sub-grade has been disturbed by teaming or other causes, it should be brought to its former surface, and thoroughly saturated with water. The concrete should be deposited rapidly to the required depth and width. The section should be completed to a transverse joint, without the use of intermediate forms or bulkheads, or a transverse joint may be placed at the point of stopping of the work. In case the mixer breaks down the concrete should be mixed by hand to complete the section. Where reinforcement is used it should be embedded in the concrete before the concrete has begun to set; and the concrete above the reinforcement should be placed within 20 mins. after the placing of the concrete below.

In two-course pavements the top should be placed within 20 mins. after the placing of the bottom.

Finishing—The surface of the concrete should be struck off by means of a temnal and transverse motion. The excess material accumulated in front of the template should be uniformly distributed over the surface of the pavement except plate moved with a combined longitudinear the transverse joint, when the excess material should be removed.

The concrete adjoining the transverse joint shall be dense and any depressions in the surface shall be filled with concrete of the same composition as the body of the work. After being brought to the established grade with a template, the concrete should be finished, from a suitable bridge, with a wood float to true surface. A metal trowel should not be used.

Brooming of the surface is not necessary and grooves are objectionable even on grades.

9—RETEMPERING

Retempering of mortar or concrete which has partially hardened, that is, mixing with additional materials or water, is strongly condemned and should not be permitted.

10—PROTECTION AND CURING

Even the best concrete may be seriously damaged by too rapid drying out, early exposure to low temperature, or by being opened to traffic at too early a period. Hot sun and drying winds are most liable to dry out the concrete too rapidly, thus causing shrinkage cracks or causing a surface which will not wear well under traffic. The use of a canvas covering will be found effective in overcoming this condition.

Sprinkling should also be employed as soon as the concrete is hard enough to prevent the surface from being pitted. An earth covering or protection by ponding should be employed after the first day. Under most favorable conditions such protection should be given the pavement for at least 2 wks. Water should be added during this period to keep the traffic in less than 2 wks., and when at least 4 wks.

In cool weather it is often advisable to omit the earth covering, thus allowing the concrete to harden more rapidly. Sprinkling should not be omitted during the day in case the surface shows a tendency to dry out. When there is danger of frost, sprinkling should be omitted and a covering of canvas or straw and canvas used.

Placing concrete in roads and pavements in temperatures at or near freezing is not advisable, and if in special cases, such work is unavoidable, the water and aggregate should be heated and fresh work protected, and precaution taken to protect the concrete from freezing for at least 10 das. Chemicals to lower the freezing temperature of the mixture should not be used.

Concrete should not be deposited on a frozen sub-grade.

11—OPENING TO TRAFFIC

Under most favorable conditions a concrete pavement should not be opened to traffic in less than two weeks and when conditions permit this interval should be at least four weeks.

12—ONE-COURSE PAVEMENT

Where the materials most readily available are such as to give good construction in one-course pavement, this convention recommends that the one-course be used.

13—INTEGRAL CURB

The integral curb for concrete street pavements is recommended in preference to straight curb or combined curb and gutter. Such construction eliminates the longitudinal joint along curb, maintains a permanent grade and alignment. Precaution should be taken to insure that the curb is thoroughly bonded to the pavement proper. The integral curb can be used on wide as well as narrow streets.

14—SPECIFICATIONS

Since no specifications were considered by the Conference, the Standard Specifications for Pavements and Roadways of the American Concrete Institute are recommended.

Report of Committee 1—Drainage and Preparation of Sub-Grade

Chairman, Hector J. Hughes[1]; Clinton Cowen[2], George W. Cooley[3], George A. Quinlan[4], Edward T. Beck[5].

At the outset this committee points out that every piece of road construction involves problems that are complicated by local conditions, financial as well as physical, which must be solved each one by itself. For this reason the committee felt that all it could do was to consider ways and means of obtaining as nearly as local circumstances will permit and at minimum expense a dry foundation that will provide uniform bearing power for the pavement. While it is generally agreed, the committee reports, that moisture in the sub-grade directly under the pavement is likely to be destructive to the surface in several ways, chiefly because of unequal vertical movement caused by frost action or unequal swelling or shrinkage of the soil, due to lack of uniformity in drainage, there seems to be no unanimity of opinion as whether, because perfect drainage is hard to secure, it is cheaper and better to reinforce the pavement sufficiently to withstand the stress set up by frost action of other similar movements or to take additional precautions about the drainage. The committee points out that in view of the different local conditions, it is highly desirable to spend more time and money on thorough preliminary investigations, and that such expenditures are a real economy. The salient points brought out by the committee in its report are stated in abstract as follows:

Four types of cross-section for the sub-grade are in use: (1) Sub-grade crowned parallel to the concrete wearing surface, which is made of uniform thickness. (2) Sub-grade crowned somewhat less than the concrete, which is made thicker at the center than at the sides. (3) Flat sub-grade, all the crown being given by varying the thickness of the concrete. (4) Dished sub-grade. The opinion seems to be gaining ground that the last-mentioned form, the slab thickened at the center and built on a flat or dished sub-base, is best suited to resist cracking, as well as to withstand heavy loads. Whatever form is to be used, and whether the surface is finished smooth or rough, the sub-base should be made of uniform texture, so to speak, should be finished true to the specified outline, and should be kept free from holes, tracks, and ruts until the concrete is laid.

After the removal or destruction of the perishable matter, the surface under new embankments should be roughened wherever the new material is likely to slide; and on the sides of old embankments, or side-hill slopes, well defined steps or benches should be made. New earth should be deposited and rolled in layers not exceeding 1′ in thickness, and the thickness should be varied according to the kind of material available and the type of roller to be used. In some cases the layers should be as thin as 1″ or 2″. In general a self-propelled roller weighing 10 tons or more will compact the sub-grade cheaply and effectively. For some kinds of silt so heavy a roller is not suitable, and better results can be obtained from lighter machines; and in other materials better results can be attained by the use of grooved rollers or tamping rollers, because the wide, smooth rollers, even when heavy, span over the soft spots. During rolling, the embankment should be kept slightly moistened.

DRAINAGE

Road drainage in general involves the disposal of (1) surface water flowing to the road from outside areas; and (2) rain falling on the road itself; and often (3) underground water from outside areas. Problems of road drainage should be approached with the fundamental idea that to be effective in protecting the road surface a drainage system must be capable of acting quickly. Underdrainage is of necessity slow drainage as compared with surface drainage; and every reasonable provision should be made to dispose of surface water coming to the roadway by surface drainage, and to keep it out of the foundation. The conditions imposed by the location often make it necessary that surface water shall be handled by underground channels or even underdrains; but in such cases the underdrains should be proportioned for storm-water capacity and not as for underdrainage alone.

If the roadbed is in finely divided, retentive, water-bearing soil, some system of underdrainage should be devised that will permanently lower the water table beneath the concrete, and keep the subgrade uniformly dry for a sufficient depth to eliminate the destructive movements caused by freezing and thawing or resulting from alternate saturation and drying of the soil. Finely divided material is in itself slow-draining, and other things being equal, the finer the material the more readily will water rise by capillarity. Underdrains in such soil necessarily operate slowly, and the work required of them should be diminished as much as possible by other expedients.

The kind of soil, the lay of the land, the amount of water and other local conditions such as the availability of suitable materials, will determine the method of underdrainage to be employed. The choice would in general be from among the following: (a) Pipes of vitrified clay or cement concrete laid in trenches, backfilled with the material excavated from the trenches, that is, "farm drains." (b) Pipes laid in trenches backfilled with broken stone, gravel, cinders or similar open material. (c) Trenches filled with stone or gravel, without pipes, "blind drains." (d) Layers of cinders, gravel, broken stone or similar material varying in thickness from a few inches to 12″ or 15″, under the entire road surface. (e) A layer of similar material laid in a shallow longitudinal trench with the cross-section of a flat letter V, and known as "V" drains. (f) Two or more of these methods used in combination.

Of the three types of trench drains, a pipe covered with coarse gravel or similar filling, for the whole depth of the trench, is the most effective. It will act more quickly than the farm drain, or the blind drain; has more capacity, other things equal; and it serves quickly to take care of that part of the surface water that in most cases eventually gets into the ground.

Pipe drains smaller than 4″ in diam. should not be used, and a larger size is better. Drains should be given as much fall as feasible to facilitate the removal of silt and to increase their capacity. Water will flow on very flat grades, but more slowly, and in general drains laid on a flat grade will not lower the ground water so much, nor drain so large an area as on steeper slopes. The depth of drains is an important factor in determining the area drained, and to a certain extent the uniformity of drainage. In very fine soils the slope of the ground water table toward the drains must be very steep, in order to carry off the necessary amount of water, often as steep as 1 in 10, and occasionally steeper. Drains should be laid at least 2′ 6″ to 3′ below the sub-grade, and 4′ is often better.

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[2] State Highway Commr., Columbus, Ohio

[3] State Engr., Minn. State Highway Comm., St. Paul

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[5] Edward T. Beck & Co., Contractors, Cuba, N. Y.

Report of Committee 2—Economical Widths of Pavement and Shoulders

Chairman, J. J. Cox[1]; William W. Marr[2], A. J. Rockwood[3], William A. Stinchcomb[4].

Committee 2 presented recommendations on economical widths of pavement and shoulders, in which the Conference did not completely concur, particularly with reference to single track roads. Briefly, the committee recommendations were as follows:

Where traffic demands a hard-surfaced highway, as obtained with Portland cement concrete, this traffic also demands a double-track road. The minimum width of concrete roads should be 15′, with such increase in width as is demanded by traffic conditions. We do not believe that the shoulders should be presumed to take a part of the traffic as is done in a great many instances. Committee recognizes that sometimes the construction of a single-track concrete road is justifiable, but would rather consider each of such cases as exceptions to the rule. Where single-track roads are constructed the width of paving should be 8′ to 10′; for double-track roads 15′ or 16′; for triple-track roads 22′ to 24′.

Committee believes that economy can be practiced by building all shoulders to concrete roads from the native soil. The soil will permit of some turnout traffic, and will amply provide for the maintenance of the roadbed under the concrete. Where shoulders will not stand up under the turnout of the traffic along a concrete road, an additional width of concrete is demanded. Recommend that 5′ be the minimum width of shoulder and that no width less than 4′ is satisfactory under any conditions. The minimum width of any road grade, even when provided with a single-track concrete road, should be 20′. The wear occurring at the junction of the shoulders with the paved surface, which forms a rut that permits the collection of water, thereby endangering the sub-base of the road, can be prevented to a great extent by constructing a vertical edge on the concrete, and rounding the top corner with a curve having a radius of from ¾″ to 1″. Then the shoulder of the road will not lap over a portion of the concrete, thereby forming a thin edge, wedge-shape in cross-section, of a material which will not bind to the concrete and which dries out and becomes loose, when it is not in a condition to resist wear.

The use of such materials as crushed stone and high-grade gravel to surface the shoulders of a concrete road are uneconomical. They do not readily consolidate under the light traffic to which they are subjected; form in ruts and prohibit perfect surface drainage, and do not accomplish the purpose desired. Neither can these materials, on account of their location at the outer edge of the road, be bound together satisfactorily by the use of water and rolling with a road roller, as in the case of macadam road construction.

Greater economy would have been obtained by putting this extra expense of constructing metal shoulders into extra widths of concrete. The only exception to this statement is when the road happens to be so located that a good consolidating gravel can be obtained at low cost.

E. W. Stern, N. Y. C., believes that widths of 15′ and 16′ are not enough for double-track roads. He recommended a minimum of 20′, urging that it is much more expensive to maintain shoulders than to build additional widths of concrete.

K. H. Talbot, Pittsburgh, urged that 8′ is too narrow for a single track and that 10′ is the proper width. In maintaining his point he said that in communities that cannot afford a wide road and must build a narrow road in order to have a permanent construction at all they cannot afford the high maintenance which is necessary to keep the shoulders in order on the narrow width of highway.

H. J. Kuelling, Milwaukee, reported that while Milwaukee county had built many roads 16′ wide, this width had been discontinued and that the 18-ft. width is favored for double-track roads. He made the point that on a road where the daily traffic amounts to about 3,000 vehicles, the narrow width of double track road is much more dangerous than on a busier road where the traffic is as high as 5,000 per da. With greater traffic, driving is done more carefully than with fewer vehicles. Where it is common to drive in the middle of the highway, accidents are more apt to happen in turning out on a narrow width of double-track road. Major A. A. Fries said that in the vicinity of Los Angeles a great many roads of 16-ft. width have been built and that they have proved rather unsatisfactory where there is a very large motor traffic, so that efforts are now being made to increase the width of double-track roads to 20′.

George A. Ricker, New York, reported that in his state where practically no single-track roads are constructed, the law will not permit the highway department to construct double-track roads wider than 16′ and that broken stone shoulders 6″ deep are maintained 2′ to 3′ wide on each side. Edward N. Hines, Detroit, said that Wayne county, Mich., had built roads 10′ wide, 12′, 15′, 16′ and 18′ wide, but the standard road is now 18′. He maintained that a 12-ft. road is dangerous because of the expectation on the part of drivers that there will be room to pass without getting off the concrete. He said that the experience of Wayne county had been that the maintenance of shoulders would actually pay for a greater width of concrete. Mr. Hines said that in Wayne county, where there were about 40,000 automobiles in 1915, the 9-ft. road is economical for single-track highway, although 10′ is better, the extra foot costing about $1,000 per mi. He recommended a width of 24′ for triple-track roads.

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Report of Committee 3—Problems of Design, Thickness, Crown and Grade

Chairman, Ira O. Baker[1]; Thomas H. MacDonald[2], H. L. Bowlby[3], Eugene W. Stern[4], R. C. Hunt[5].

An abstract of the committee's report in its more important recommenations is as follows:

The proper thickness of a concrete road depends to a material degree upon: (1) The climate. (2) The width of the slab. (3) The character of the soil. (4) The thoroughness of both the surface and under drainage. (5) The degree of consolidation of the sub-grade. (6) The proportions and quality of the concrete. (7) The character of the workmanship of every part. (8) The care employed in curing the concrete. (9) The character of the traffic. These factors are not of equal importance, and the importance of any one item may vary considerably with local conditions.

Probably all that can ever be done toward determining a working rule for the thickness of a concrete road slab is to accumulate data concerning practice. In this connection, it should not be forgotten that often the failures are more instructive than the successes.

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In California, part of which state is classed as semi-arid and part as arid, the State Highway Commission has laid many miles of concrete roads 16′ and 18′ wide and only 4″ thick, which have given entire satisfaction.

In Oregon, a state that is chiefly semi-arid, many miles have been built 16′ wide with a thickness of $5\frac{1}{2}$″ at the sides and $6\frac{1}{2}$″ at the crown, which competent authority pronounces as being satisfactory. In 1914 3 mi. of 16-ft. roadway were built in which the thickness at the sides was only 4″ and that at the crown only 5″, and after 15 mos. use this road is in excellent condition.

In the Mississippi Valley, the general practice seems to be to make the thickness 6″ at the side and 7″ or 8″ (usually the latter) at the crown, and in other respects to conform to the specifications proposed by the American Concrete Institute and adopted by the 1914 session of this Conference. Practice is so variable in the different elements affecting the thickness of the slab, that it is impossible to discover any definite relationship between thickness and width.

A country road need be crowned only enough to afford lateral drainage, particularly after the middle is worn down somewhat; while on a city street with side curbs, the crown should be enough to prevent an undue portion of the pavement from being covered with water during a rain.

The crown used in practice for concrete roads without curbs, varies from $\frac{1}{24}$ to $\frac{1}{200}$ of the width, without much tendency to group within any smaller limits. For concrete pavements with curbs, the crown employed in practice varies from about $\frac{1}{50}$ to $\frac{1}{150}$ of the width, the intermediate values being used about equally.

The standard specifications for concrete roads adopted by the 1914 session of this Conference call for a crown of $\frac{1}{100}$ of the width; and this committee sees no reason to change this recommendation. However, one member of the committee believes that in the Mississippi Valley a crown of $\frac{1}{150}$ is not too flat, and another member believes that in a warm and arid region a crown of $\frac{1}{200}$ is justifiable.

The maximum grade permissible for a concrete road surface depends upon: (1) The climate. (2) The character of the traffic. (3) The finish of the surface. In a humid climate, frost or ice may render a concrete pavement slippery; but in an arid climate this difficulty does not occur. The ordinary method of finishing the surface of a concrete pavement with a wooden float gives a surface having as good a foothold as wood or sheet asphalt. The surface of concrete roads or pavements is sometimes grooved, or scored, or corrugated to make it less slippery; but the practice is believed to be unwise, since the corrugations weaken the slab. In the arid regions, a few concrete roads have been built with 10% grades; and grades of 5% and 6% are common and entirely satisfactory.

In the Mississippi Valley, concrete roads and pavements have been constructed having grades as high as 7% or 8%; but the usual testimony is that such pavements are slippery even when there is no frost or ice. In a humid climate, a grade of 5% or 6% is about the limit for a concrete surface finished with a wood float. However, one member of the committee claims that a 7% grade is not slippery in Iowa, and cites the case of a 12% grade on a main street in Platteville, Wis., which teamsters prefer to any other pavement in the town.

Report of Committee 4—Aggregates for Concrete Roads

CHAIRMAN, D. A. ABRAMS[1]; W. K. HATT[2], H. S. MATTIMORE[3], A. S. REA[4], CHARLES F. SHOOP[5].

It is noteworthy that the report of the committee on Aggregates for Concrete Roads, while representing one of the most important considerations in connection with concrete road building, prompted less discussion perhaps than several other committee reports. Whether this is a compliment to the thoroughness of the committee's work or an indication of uncertainty about moot questions can only be surmised.

A development is the more general recommendation that coarser stone should be used in concrete road construction than formerly. There was a division of opinion as to whether the maximum size of stone should be $1\frac{1}{2}$″ or 2″. It seemed to be generally felt, however, that a larger aggregate makes for economy and that a large stone, even considerably larger than 2″, if pressed into the concrete so as to present a flat surface to wear will give the very best kind of wearing surface. This committee stood decidedly against the use of run of crusher stone or run of bank gravel or other ready prepared mixes of fine and coarse aggregate. The committee held:

Experience has shown, other factors being equal, that the life of a concrete road depends on the following qualities of the aggregate: Durability of particles (toughness, strength, hardness, brittleness, density, resistance to wear, impact, abrasion, etc.); grading (size and shape of particles, amount of voids, etc.); cleanness (amount and character of impurities); miscellaneous properties (chemical and mineralogical compositions, structure, etc.) These four qualities are named in the order of their importance.

On account of great economies which result from utilizing fields that are readily available and the absence of well developed sources of supply in many localities it is of prime importance that all aggregate materials for concrete roads be tested before use. The report goes into a consideration of tests to determine various qualities of aggregates and concludes with proposed specifications for aggregates for one-course concrete road as follows:

PROPOSED SPECIFICATIONS FOR AGGREGATES FOR ONE-COURSE CONCRETE ROADS

Aggregates—All aggregates used shall conform to the requirements of these specifications. Before delivery of material at the site of the work the contractor shall submit to the engineer a sample weighing not less than 50 lbs. of each of the fine and the coarse aggregates proposed for use. The engineer shall determine, by means of tests, whether or not said samples comply with the requirements of these specifications. The acceptance of samples shall not be construed as a guarantee of acceptance of other lots of material from the same source. The engineer may make tests on all lots of aggregate delivered on the work in order to determine whether or not specification requirements are met.

Fine Aggregate—Fine aggregate shall consist of natural sand or screenings[6] from hard, tough, durable crushed rock or gravel consisting of quartzite grains or other equally hard material graded from coarse to fine, with the coarse particles predominating.

Age at Test	Minimum Strength of 1:3 Fine Aggregate Mortar
72 hrs.	1.25 times (A)
7 das.	1.10 times (A)
28 das.	1.00 times (A)

(A) equals the strength of 1:3 standard Ottawa sand mortar specimens of same form and size, of similar plasticity, made by the same operator using the same cement.

Fine aggregate, when dry, shall pass a sieve having 4 meshes per lin. in.; not more than 90% nor less than 50% shall be finer than a sieve having 8 meshes per lin. in. Not more than 20% shall be finer than a sieve having 50[7] meshes per lin. in., and not more than 5% shall be finer than a sieve having 100 meshes per lin. in. The above-mentioned percentages shall be computed on the basis of weight. Fine aggregate shall contain no vegetable or other deleterious materials, and not more than 3% of clay or loam, by weight.

Fine aggregates which give a mortar strength equal to or higher than the minimum value at any of the ages named below, shall be considered as fulfilling the mortar strength requirements of this specification.

The tests shall be made on mortars composed of 1 part Portland cement and 3 parts, by weight, of fine aggregate or standard Ottawa sand. The test specimens shall be made, stored and tested in the same manner. All mortar strength tests shall be made under laboratory conditions, in accordance with recognized standards. Each value shall be the average from tests of not fewer than three specimens.

Coarse Aggregate—Coarse aggregate

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[6] Mr. Mattimore voted "no" on the inclusion of screenings under the specification for fine aggregates, and "no" on the value of 1.10 for the ratio of the strength of fine aggregate mortars to standard Ottawa sand mortar at the age of 7 das.

[7] The No. 48 sieve has openings of the same size as the usual No. 50 sieves

shall consist of clean, hard, tough and durable crushed rock or gravel. Coarse aggregate shall contain no vegetable or other deleterious matter, and shall be free from soft, flat or elongated particles.

Coarse aggregate shall be graded from 2″ down. The coarsest particles shall pass a 2-in. round opening. Not more than 5%, by weight, shall be finer than a sieve having 4 meshes per lin. in.

Ready-Mixed Aggregates—Run-of-crusher stone, run-of-bank gravel, or other ready-prepared mixes of fine and coarse aggregates, shall not be used.

In connection with the field inspection of concrete aggregate the committee's ideas in abstract are:

Field inspection of concrete aggregates is understood to include visual inspection and all determinations which can be made by means of the physical senses and such apparatus as may be found ready at hand or conveniently carried about. It is recognized that the value of field inspection depends entirely upon the experience and training of the individual making such inspection. Elements of field inspection include: A careful examination of the surroundings from which a material comes and an inspection of the operation of the plant producing it frequently furnish valuable guides. A sand which consists largely of soft particles, or is too fine, or contains a large percentage of impurities may properly be rejected on the basis of field inspection.

The grading of aggregates with reference to the amounts passing certain sieves can be determined roughly by means of a set of portable sieves. A visual inspection will reveal the presence of large amounts of clay, loam or soft pebbles in a shipment of gravel, and will indicate whether or not the material deviates largely from the proper grading.

A fairly exact determination of cleanness of sand may be made in the field by filling a cylindrical glass jar or bottle about half full of sand and adding sufficient water to cover the sand to a depth of 2″ or 3″, closing for a few seconds, then shaking and allowing the suspended material to settle on top of the sand. The length of time required for the water to become clear and the depth of the deposit on the surface of the sand give a measure of the foreign material present. This method sometimes fails in the tests of sands which, on account of the color or grading, do not show a line of separation between the silt and sand. It should be noted that the results of this test cannot be compared directly with those obtained by the usual laboratory methods made on the basis of the loss of weight.

Certain engineering organizations have provided their field inspectors with outfits consisting of two or three sieves, a glass graduate, rule, etc., which in the hands of intelligent men may be expected to give fair indications of the quality of concrete aggregates.

While the evidence of field inspection and tests should never be overlooked, it is generally recognized by progressive engineers that such tests are not sufficient for the purpose of discriminating among several lots of available materials, all of which may be of a good grade. Differences in the grading, hardness, silt content, etc., of sands exert such an important influence on the strength, durability and water-tightness of concrete that the selection of suitable aggregates cannot properly be left to makeshift methods. Most engineers are now agreed as to the importance of properly-made laboratory tests for determining the relative value of aggregates for use in concrete roads.

Report of Committee 5 — Handling and Hauling Materials and Water Supply

Chairman, T. R. Agg[1]; H. G. Shirley[2], Edward N. Hines[3], R. N. Waid[4], E. H. Cowan[5].

The committee held that there has now been sufficient experience in the construction of concrete roads and pavements, under diverse climatic and topographical conditions, to make possible some fairly definite conclusions as to methods of handling and hauling materials, and that these methods are very important as representing a large item of cost and that not only the cost of hauling itself is important but the efficiency of hauling methods will to a certain extent limit the efficiency of other parts of the concreting organization. The whole work hinges on the capacity of the mixer, and it is therefore important that an adequate supply of material be maintained so that the mixer will work to full capacity.

One consideration strongly emphasized by the committee is the fact that high prices are paid to secure clean aggregate and then hauling conditions are such that the materials are placed on the roadbed in such a way that much of the material becomes mixed with the dirt, which causes great loss of quality. The committee points out that it is extremely poor economy to employ a method of handling and hauling that exposes the material to the possibility of becoming mixed with foreign material.

The committee also points out that inasmuch as increasing attention is being paid to proper proportioning of the aggregate for concrete road and pavement construction it becomes important that in handling the aggregate a method shall be adopted which will simplify and facilitate this exact proportioning. Emphasis was also put upon the fact that some methods of handling materials result in considerable damage to the subgrade, inasmuch as hauling represents a very large item of cost, particularly when the haul exceeds 2 mi. to 3 mi. it is important that most careful consideration be given to various methods of getting the material onto the work. There are four types of equipment available, horse-drawn vehicles, motor trucks, steam or gas-tractor trains and industrial railways. The report of the committee on these various methods of handling materials is given in abstract form as follows, together with a summary covering the major points of the report:

Team Hauling—Team hauling has been so universally employed that its cost and limitations are well understood. No other type of equipment is as well adapted to work in congested districts and under diverse, but well defined physical limitations. If materials must be hauled from a congested freight yard through a congested business district, and finally out over unimproved earth roads with an indifferent or poorly maintained trackway, no type of equipment is so well adapted to requirements as the horse-drawn, bottom-dump wagon. The cost of hauling under such conditions will inevitably be high, and the range of economical operation is limited to about 2 mi.

Motor Trucks—Motor trucks are second to teams in adaptability to diverse conditions. So long as a suitable trackway is provided they can operate anywhere that a team can go, but if an indifferent trackway is maintained, and if the hauling must proceed over the subgrade, the damage, especially following wet weather, is likely to be considerably greater than when teams are used. From the standpoint of cost, it seems probable that where teams can haul three 2-yd. loads per day, it will be more economical to use teams than motor trucks. If the haul is long and the speed of the truck, therefore, becomes an important factor, it seems probable that the truck designed for a 3-ton load and for high speed will prove more economical than the heavy, slower-moving truck. A truck of this size also has the advantage that it is less hampered by adverse roadway conditions than is the heavier truck. The 3-ton truck can be counted on for an average of at least 45 mi. per da., and under favorable weather conditions will make 60 mi. per da. Successful operation of the motor truck depends upon the physical conditions being satisfactory, and, to a very great extent, upon the skill and care of the driver. If handled carefully, it is exceedingly dependable and the operating and maintenance costs are reasonable; but if handled carelessly, both operating and maintenance costs will be excessive.

Tractor Trains—Tractor trains have been used extensively for hauling road materials but are less adapted to diverse conditions than the motor truck or horse-drawn wagons. The tractor is slow-moving and the capacity per outfit is relatively small since only a limited number of trips can be made per da. Three mi. per hr. is about the best speed that can be expected with the tractor. The load that can be hauled will vary with the stability of the road, but will not exceed, under the most favorable conditions, about 25 tons. The weight of the truck should not be too great on account of possible damage to the roadway; a train of several moderate-sized units is better than a few large units. The weight of the truck and load should preferabl be less than 6 tons and even for trucks of this weight the wheels should be at least 6″ wide.

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Adverse weather conditions affect the economy of tractor hauling very materially, since the tractor cannot travel on soft or slippery roads. The damage to the sub-grade and shoulders will be greater with this equipment than with any other type because of the weight of the machine and the room required for maneuvering. The cost of hauling with this type of equipment ranges from 10 cts. to 30 cts. per ton mi.

Industrial Railroad — The industrial railroad is adapted to work where the haul exceeds 2 mi. and where the facilities for unloading the materials are such as to permit adequate switching facilities and ample storage bins.

The industrial railroad has the advantage of being little hampered by unfavorable weather conditions, and of being capable of considerable variation in capacity without great additional expense. The item of expense that is greatest is the cost of track and as soon as track is provided for, the number of trains operated can be varied considerably by varying the number of cars and locomotives. The capacity of such an outfit is also limited to some extent by topographical conditions, since the geared locomotive must of necessity be used where the grades exceed about 4%, and a locomotive of this type travels slowly. Where the grades are less than 4%, and especially where they are less than 2%, industrial railway trains can be depended upon for 8 mi. per hr. as an average throughout a season. The size of train will, of course, depend upon the grades, but ranges from 20 tons to 40 tons. The cost of hauling with this equipment ranges from 6 cts. to 15 cts. per ton mile.

HANDLING AGGREGATES

Unloading from Cars—It is highly desirable, as has been already noted, that there be available at all times an adequate supply of aggregates, and since railroad delivery is almost certain to be somewhat erratic at times some storage facilities must be provided. For small work, that is, a few miles in a place, materials may be stored by unloading from the cars directly into a storage pile and, when sufficient reserve is on hand, the remainder of the materials can be hauled directly from the cars. The storage pile will be hauled from only when car shipments fail. If any method of hauling, except teams, is employed, such a storage pile is unsatisfactory because of the high cost of reloading. For mechanical haulage of any kind, storage bins of sufficient capacity to hold at least two railroad carloads of aggregates are the economical arrangement. On work involving several miles of concrete roads, the aggregates are preferably unloaded from the cars into the storage bins, either by a locomotive crane with clamshell bucket or by dumping from the railroad cars into a track hopper and elevating the aggregates to storage bins by means of a bucket elevator or belt conveyor. The materials can then be discharged into the trucks or industrial railway cars through spouts in the bottom of the bin. The cost of unloading aggregates by hand is about 10 cts. per ton and the cost of unloading by means of the locomotive crane or the bucket elevator will range from 4 cts. to 8 cts. per ton. Storage in bins is much preferable to storage in piles on the ground unless the storage piles are placed on a plank platform.

Feeding the Mixer—Requirements for this work are governed to a large extent by the desire to secure uniformity in proportioning; but if any system is used which involves dumping the materials on a sub-grade or on the shoulders, best practice is to require that they be placed on wooden platforms. Industrial railroad cars can be arranged so as to dump directly into the mixer, thus eliminating all possibility of dirt becoming mixed with the aggregates, and also insuring uniformity in the batches. The industrial railroad cars are divided by partitions into two compartments of suitable size for the sand and stone so that a proper quantity of each for one batch will be placed in each car. Cement is hauled on flat cars so that each train load of aggregates includes all materials necessary for the concrete.

Report of Committee 6—Organization of Concreting Crew

CHAIRMAN, H. P. GILLETTE[1]; E. I. CANTINE[2], WM. F. MCVAUGH[3], WALTER BUEHLER[4], O. T. DUNLAP[5].

The committee pointed out that four factors of operation influence progress of the work in concreting and that all of the four operations must be well in hand and the organization based upon all four of them operating in relation to each other. First, there is the quarry and the crushing plant or other supply of concrete aggregates, (2) the motor trucks or other means used to deliver the materials on the road, (3) the pumping plant which must supply the large quantity of water used not only on the sub-grade but in the concrete and in curing the road, and (4) the mixer, which is the central unit in the actual concreting operations. Let any one of the first three go wrong and the last, the mixer, must shut down. The committee pointed out the value of a dispatcher who makes his headquarters at the source of supply of the materials, who will see to it that the contractors for sand, rock or gravel live up to their agreements and that cars are at hand when needed to send materials forward. It is pointed out that practically all the delays in concrete road work aside from those resulting from weather conditions are due to irregular arrival of materials needel in the work.

The committee pointed out the importance of having someone assigned to the work of seeing that teamsters and truck drivers place accurately the piles of materials which are brought in, so that no subsequent moving of the materials will be necessary. Further than this it is important to see that the loads are practically uniform in size.

In taking up a consideration of the organization of the concreting crew as influenced by physical conditions on the work, the committee names five points for the contractor's consideration before he decides definitely on just how much work he can count upon from a mixing crew of given size. These five points are as follows: Placing of materials, experience of men, width of streets, obstruction, such as car tracks, character of sub-grade.

The committee mentions that the placing of the sand and gravel should be so arranged that the piles will not be too near the mixer and in having the materials properly spaced it must be remembered that the number of square yards that a mixing crew of any size is capable of laying varies inversely as the distance of the materials from the mixer. If the materials are too near the mixer, however, there is confusion at the hopper, where there is insufficient room for men to pass with loaded and empty wheelbarrows.

In connection with the experience of the men it has been found advisable to use a few extra men on the aggregate at the beginning of the job if the crew is inexperienced. The extra men are usually shovelers to load the wheelbarrows for the wheelers. Some contractors so arrange their crews as to have some men loading and others doing the wheeling, while another plan is to have the men load their own wheelbarrows, giving each man a variety of work.

As to the width of the street a greater yardage of concrete can be laid on wide streets than on narrow streets with a crew of given size. It was found by an investigation of a number of jobs that this increase is regular from a 13-ft. street up to a 30-ft. street. On a 13-ft. street the average daily yardage was 600 sq. yds.; a 24-ft., 750 sq. yds.; a 25-ft., 850 sq. yds.; a 27-ft., 917 sq. yds., and a 30-ft., 950 sq. yds. In spite of this fact investigation failed to show that contractors reduced the size of their crews at the mixer on narrow roadways. No exact figures were obtained but some of the contractors seem to feel that they had experimented with smaller sized crews unsatisfactorily.

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In the matter of obstructions on the roadway, such as car tracks, it is found that labor charges per sq. yd. of pavement are higher on such streets, as the passing of cars tends to disorganize the work. It has been the experience of one contractor that when concreting is done on a street where there is a railway down the center the crew which on a 25-ft. street would average 850 sq. yds. a day could do no better than an average of 600 sq. yds. a day with the street car line. In this particular case the pavement was 13′ wide on each side of the track.

In connection with the character of the sub-grade this will determine whether or not the wheelbarrows are to be used directly on the sub-grade or are run on planks.

From the information gathered by the committee and here abstracted in brief, the following conclusions are drawn:

The foregoing considerations, while they figure conspicuously in determining the number of square yards of road or pavement that a mixing crew of given size is capable of turning out daily, do not to any appreciable extent enter into consideration in determining the size of the mixing crew. There are really only two considerations which are of paramount importance in determining the number of men in any crew.

(1) The size of the mixer batch to be used, that is, whether it is a one-, two- or three-sack batch. (2) The placing of the aggregates. This consideration, however, is one that can be, with a little study, eliminated from any job, for with the proper placing of the aggregates no additional men are needed to assist in the long haul.

For the average job it would be a fair rule to follow, to use one shoveler for each wheeler, the number of wheelers being determined by the size of the batch, and in no case should a man be required to wheel more than 2½ cu. ft. of sand or gravel. The number of men on the cement would be two for a two-sack batch and the same number for a three-sack batch. When a three-sack batch is used the men could alternate in making the extra trip.

The crew that can be worked most economically under average conditions should be made up as follows: Using two-sack batch, mixture 1:2:3—Cement, 2 men from piles. Sand, 2 wheelers, 2 shovelers. Gravel, 3 wheelers, 3 shovelers. Helper, 1 at mixer hopper. Three-sack batch, mixture 1:2:3—Cement, 2 men from piles (alternate). Sand, 3 shovelers, 3 wheelers. Gravel, 4 shovelers, 4 wheelers. Helper, 1 at mixer hopper.

The shovelers may be cut down to two on gravel when the street is narrow, but under ordinary conditions it will be found better to have a separate wheeler and shoveler for each wheelbarrow. The helper at the hopper is not a common hand on the average crew, but we believe that he can be used to advantage in helping to keep the wheeling planks in line, if planks are used, and in assisting the wheelers to dump the barrows so that the materials are thrown well back into the hopper.

The committee gave numerous examples of concreting crews. An example supplied by William D. Uhler, Chief Engr. State Highway Dept. of Pennsylvania, was in connection with the Easton-Allentown road.[6] The crew was as follows:

Gang	Cost per da.
1 foreman at $3.00	$ 3.00
1 mixer operator at $3.00	3.00
1 fireman at $2.50	2.50
2 template men at $2.00	4.00
3 men spreading at $2.00	6.00
2 men floating at $2.00	4.00
1 man finishing at $2.00	2.00
2 men on forms at $2.00	4.00
1 man changing chute at $2.00	2.00
2 men handling cement at $1.75	3.50
7 men on wheelbarrows at $1.75	12.25
7 men shoveling at $1.75	12.25
1 utility man at $1.75	1.75
1 waterboy at $1.50	1.50
32 men. Total labor cost per da.	$61.75

The first tasks in each day's work were to bring forward from the previous day's work the forms and other working appliances and to cover the previous day's concrete with earth. All such men as template men, floaters and finishers were employed in this task. The three men handling concrete placed the expanded metal reinforcement and the expansion joints also. Laying a slab 7″ thick and holding the material in the drum for a 90-sec. mix, this gang averaged 525 sq. yds. per da. at a labor cost of approximately 11.7 cts. per sq. yd. A No. 16 Koehring[7] paving mixer, with boom and bucket delivery, was used. With a shorter mixing time, say 45 sec., it is suggested that the gang be increased three men to five men on wheelbarrows; with such an increase it is estimated that the yardage could be increased 50%.

The second example was on Illinois state aid road work and the data covered experience based on 25 or 30 different jobs, representing a total of about 500,000 sq. yds. of pavement. This organization assumes the excavation complete and all material delivered on the work and that the sub-grade is in average condition. The crew then consists of the superintendent and a foreman, 2 men wheeling sand, 4 men wheeling stone, 2 extra shovelers, 2 men handling cement, 1 man handling sacks, and 1 man or 2 men trimming sub-grades, these men working in front of the mixer. Behind the mixer there are 3 or 4 shovelers, 1 finisher, and 2 men attending to the curing of the concrete. Working on the mixer—1 engineer and 1 fireman. Working on the forms there are 2 men; on the water supply, 1 pumpman; miscellaneous employees consist of 1 watchman and 1 waterboy. This gives a total of from 27 to 29 men. The gang is for a two-bag batch mixer and with this machine the average daily output pavement 18′ wide and 7″ thick is about 800 sq. yds., working 9 hrs., mixing time per batch 35 sec. The average cost of mixing and placing of concrete and of setting the forms and placing joints is 10 cts. to 12 cts. per sq. yd. A single day's cost may run as low as 8 cts. per sq. yd., but an average job of any size, figuring repairs, fuel, and depreciation on mixer, brings the cost between 10 cts. and 12 cts. where labor receives from 20 cts. to 25 cts. per hour. A smaller gang will reduce the unit cost slightly if no account if taken of interest, overhead, etc. The slower progress made by the smaller gang will, however, run up the fixed charges so that in the end the cost is greater than with the larger crew. These data were supplied by H. B. Bushnell, Division Engr., Illinois State Highway Dept.

In summarizing the report of this committee, the chairman, Mr. Gillette, said that as a usual thing the crews required on contract work were less in number than those where the work is done on the day labor plan. Mr. Kuelling, of Milwaukee Co., Wis., on the completion of the report, rose to correct this statement, saying that for the day labor work done in Milwaukee Co. the number of men was usually 32, while the number of men on the contract job was usually 45. The report as presented gave some figures as to cost of work in Milwaukee county and some corrections were made on this by Mr. Kuelling. The report listed the number and wages of men used on the force account work in 1913 in Milwaukee Co. as follows:

Men	Cost
1 foreman	$ 5.00
1 assistant foreman	3.50
1 mixing engineer	3.50
1 fireman	2.75
1 finisher	3.00
3 wheeling concrete at $2.67 per da.	8.00
3 handling sand at $2.50 per da.	7.50
2 handling cement at $2.50 per da.	5.00
8 handling stone at $2.50 per da.	20.00
2 forms and joints at $2.50 per da.	5.00
1 evening and tamping	2.50
1 covering and sprinkling	2.50
1 pump man	2.75
1 waterboy (cared for cement sacks).	1.50
1 watchman	2.25
28 men. Total labor cost per da.	$74.75

Average, 500-600 sq. yds. (95-115 cu. yds.) per da.

The mixture used was 1:2:3½ and the road was 18′ wide, 6″ thick at the edges and 8″ thick in the center, and under favorable conditions the gang completed 600 sq. yds. per da. The report then gave the cost of concreting labor on four separate roads built in Milwaukee Co., and Mr. Kuelling made a correction here in the committee report by saying that the labor cost per sq. yd. for concrete was based on the figures given in the annual report, which covered other items than concrete, such for instance as handling materials from cars, trimming shoulders, cleaning ditches, etc., making a very large difference in concreting cost of the four roads mentioned. As for instance on the Port Washington Road, where the committee gave the cost as 18.7 cts. per sq. yd., Mr. Kuelling stated the cost was 11 cts. per sq. yd. for labor in concreting.

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[6] Described in the Feb., 1916, issue of CONCRETE, p. 51

[7] Koehring Machine Co., Milwaukee

The committee presented numerous other examples of concrete in gang organization and finishing this report was a summary from the examples as follows:

Using modern paving mixers, a concreting gang for road work will consist of from 30 to 40 men. These are round numbers. In instances fewer than 30 men will suffice and in more rare instances a number greater than 40 may be required. The exact number will depend upon the nature of many controlling conditions. Also the number of men allotted to the several duties to be performed is likewise determined by the nature of these conditions. As illustrating the vagaries of organization recorded in practice, Table 1 has been compiled from data readily at hand. Doubtless some of the wide variation exhibited is due to inequalities of organizing skill, but with all reasonable allowance for this cause, there remain important differences caused entirely by differences in conditions controlling the concreting work.

Table 1—Disposition of Men in Concreting Gangs for Concrete Road Work

Job	Gen.	Front	Rear	Mixer	Forms	Water	Misc.
I	1	16	9	2	2	..	2
II	2	12	7	2	2	1	2
III	2	22	8	2	2	1	2
IV	2	13	6	2	2	1	2
Base ...	1	15	4	2	..	..	..
V	(2)	(29)	(9)	(5)	(1)	.	(3)
Top	1	14	5	3	1	..	3
VI	1	5	10	1	..	..	..
Base ...	1	9	5	1	..	..	..
VII	(2)	(13)	(11)	(3)	(2)	.	..
Top ...	1	4	6	2	2	..	..
VIII	1	10	11	3	2	..	..

Concreting is but one operation in the process of concrete road building. The target is the lowest cost of the whole process, and the concreting operation must so co-ordinate with other component operations that the mark is hit. It may often happen, therefore, that the most efficient concreting gang organization is not the one that will mix and place most cheaply a cubic yard of concrete in finished road slab, considering this one operation as the beginning and end of all effort. The law of co-ordination has influence in an even more minute way. Consider for the moment the concreting operation to be independent of all others. On the Pennsylvania road work described previously, the requirement was that the batch should turn 90 sec. Under this requirement, the most efficient gang organization has been found to be that of column one in Table 2. Could the mixing period be cut in half, the most efficient gang organization would be that of column two in Table 2. Again, consider the gang organization for Illinois road work. By reducing this gang by a few men it is stated that a smaller unit labor cost could be obtained, but the slower progress would increase interest and overhead costs enough to exceed the saving.

Table 2—Gang Organization and Output as Influenced by Time of Mixing

Thus -	1	2
Mixing time, sec..............	90	45
General labor	1	1
Men in front	16	21
Men in rear	9	9
Men on mixer	2	2
Men on forms	2	2
Miscellaneous	2	2
Total men	32	37
Output sq. yd. average..........	525	787

In indicating the great variations in the number of square yards which a crew can take care of in one day, Mr. Gillette pointed out that it is fair for the contractor to assume that the average daily yardage should be about one-half of the greatest daily record. He mentioned in connection with handling materials that it is very common on California work to train men as shovelers in handling large quantities of material. When a man has been especially trained up for this work he is paid from 25% to 50% more than the regular daily wage, in order to get a high efficiency. While the daily wage is high in California on work of this kind, there is a low unit cost for handling material.

In a further correction of the impression conveyed by the committee reporting on organization, Mr. Kuelling said that in his experience he believes that on day labor work the crew would be from 10 to 12 men less than on contract work. He gave the number for contract work as 38 and the number for day labor work as 28.

While there was some disposition to assume that in force account operation where there are apt to be certain political influences to keep the gange of men at a maximum in numbers it was pointed out by Ira O. Baker that where there is a good engineer in charge who is left with a free hand entirely uninfluenced by any political consideration that force account work is done as well or better economically than on contract. The principal advantage of work done this way is in the fact that it permits a permanent organization of men trained for special duties, while the ordinary road contractor finds it impossible to keep the gang together all the year around. Then, too, it was pointed out that on work done on a large scale by a county or by the state it is possible to effect economy by having suitable equipment which a contractor perhaps could not afford to buy for scattered jobs of comparatively small yardage. The county or the state can afford to own it by reason of a continuous work program and connected roads.

Report of Committee 7—Proportions of Materials and Consistency of Concrete

Chairman, W. S. Gearhart[1]; A. N. Talbot[2], W. M. Acheson[3], H. S. Van Scoyoc[4], F. L. Rice[5].

The committee on Proportions of Materials and Consistency of Concrete pointed out that while it is common practice at the present time to proportion materials for concrete roads by the method of arbitrary selection, that is, by specifying the number of parts of different ingredients, emphasis is laid on the fact that this is a most unscientific method of proportioning materials, but its general use has seemed to justify it because of the facility with which work can be handled under existing conditions. The committee says that unless the character of the aggregates to be used and the quality of concrete made with the specified proportions of ingredients are carefully determined, this method should not be used, for a 1:2:3 mixture in one case may be identical in quality with a 1:2:4 mixture or even a 1:2½:5 mixture in another, on account of the variation in size of aggregates. The committee says further that unsatisfactory concrete will result from the best aggregates if they are not properly proportioned. In making recommendations for the proportions of the several classes of concrete for roads and for streets, the committee points out that while these proportions represent the best practice at the present time they should not be used without a thorough appreciation of the defects in the method of arbitrary selection. These recommendations are made with the understanding that the Portland cement used complies with the Standard Specifications of the Am. Soc. for Test. Mat.; that the fine and the coarse aggregate will meet the standard specifications for concrete roads and pavements of the Am. Concrete Inst. for 1914; that the character of these materials and the quality of the concrete made with the specified proportions of these ingredients will be determined by careful tests; and that the coarse aggregates shall consist of sound, hard stone or gravel having a French coefficient of wear of not less than 10 for one-course construction and for the wearing course of two-course construction and not less than 7 for the base of two-course construction. The recommendation as to proportions of concrete are as follows:

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[1] Kansas State Engr., Manhattan, Kans.

[2] Prof. of Municipal and Sanitary Engrg., University of Illinois, Urbana, Ill.

[3] Div. Engr., N. Y. State Highway Comm., Syracuse, N. Y.

[4] Chf. Engr., Toronto-Hamilton Highway Comm., East Toronto, Ont.

[5] F. L. Rice & Sons, Shelby, Ohio

One-Course Concrete.—For a one-course concrete pavement the materials should be mixed in the proportions of 1 sack of Portland cement, 2 cu. ft. of fine aggregate and 3 cu. ft. of coarse aggregate, and a cu. yd. of the resulting concrete in place should contain not fewer than 6.8 sacks of cement.

Two-Course Concrete.—For the base of a two-course pavement the materials should be mixed in the proportions of 1 sack of Portland cement, 2½ cu. ft. of fine aggregate and 5 cu. ft. of coarse aggregate, and a cu. yd. of the resulting concrete in place should contain not fewer than 5.6 sacks of cement.

If the base is to consist of cement and fine aggregate the materials should be mixed in the proportions of 1 sack of Portland cement to not more than 4 cu. ft. of fine aggregate, and a cu. yd. of the resulting concrete in place should contain not fewer than 8.2 sacks of cement.

For the wearing course of a two-course pavement the materials should be mixed in the proportion of 1 sack of Portland cement to not more than 2 cu. ft. of fine aggregate, and a cu. yd. of the resulting concrete in place should contain not fewer than 11.8 sacks of cement.

The committee reports that many experiments in concrete road construction have been made recently with hydrated lime added to the concrete in amounts ranging from 5% to 10% by weight of the cement. Information available at the present time seems to indicate, however, that the addition of the small percentage of some inert material, such as hydrated lime, may be of value in concrete road construction, for it decreases the percentage of voids and produces a more nearly impervious concrete and reduces the expansion and contraction under moisture changes, but at this time the committee felt that it was not warranted in making any definite recommendations.

The committee found difficulties in connection with the consistency of concrete because the terms used in defining consistency are generally indefinite. To one man it may mean an entirely different thing from what it means to another man. Inquiries sent out as to the proper consistency of concrete resulted in some interesting replies. The consistencies used in road construction were described variously as follows:

"Plastic;" "Plastic enough to retain its shape when screeded, and not to be so plastic that a flow of mortar will be produced on the top, or in which any segregation can take place;" "Mixture must be plastic and of such consistency that it can be troweled and will quake slightly under the trowel;" "Concrete wet enough so that it can be worked easily, yet dry enough to retain its shape—a quaking mixture;" "A quaking mixture that can be made even by tamping;" "A quaking mixture which can be struck off with template;" "Like thick cream;" "Such that a light tamping will bring mortar to the surface;" "Wet enough to produce a concrete that will flush readily under light tamping;" "Dry enough to require slight tamping to settle into place;" "Wet enough to settle in flat mass but not to run on sub-grade;" "Works easily under template;" "Requires use of hoe to keep concrete moving;" "Wet enough to flow into place with assistance of laborers and work easily under template;" "A concrete which will hold its shape when struck off with a template;" "Holds its shape when struck with template, but such that the materials will not separate;" "A consistency such that concrete can be conveyed and deposited without separation of coarse aggregate from the mortar;" "No excess water to appear after a thorough tamping;" "Consistency such that when walked onto the foot is removed with an effort and the remaining hole does not run full of mortar."

The committee reports with relation to the amount of water to be used as follows:

The amount of water necessary to produce the required consistency varies from about 6% to 12% by weight, or from 14% to 30% by volume of concrete, and from 18 gals. to 35 gals., or from 150 lbs. to 300 lbs. per cu. yd. of concrete. This great variation is largely due to the amount of moisture in the aggregates, the character of the materials and the atmospheric conditions.

The committee says, however, that while the requirements for consistency should be specified in a more definite way than is now usual, it is evident that a standard consistency cannot be expressed in terms of the percentage of water used. Further light is thrown on this subject in the report of Committee 8, that dealing with mixing and placing the concrete in connection with experiments made to determine the amount of water per cu. ft. of loose material. Like Committee 8, which reported later, Committee 7, however, especially emphasized the undesirability of mixing concrete too wet. A great difficulty is found in the fact that workmen soon learn that by using an excess of water the concrete can be mixed with less effort, and placed, handled, and finished more readily than when it is of the proper consistency. The committee pointed out that it is a matter of general observation both in the field and in laboratory work that with the same materials, other things being equal, the wet mixture is inferior in quality and strength to concrete of a medium or quaking consistency. The committee also said that it is found inadvisable to use carts in placing concrete at a distance of from 300′ to 500′ from the mixer. In conclusion the committee recommended that the consistency of concrete for road or for street work should be such that when deposited from a chute or bucket it will settle in a flat mass but will not flow on the sub-grade. No tamping should be required and no separation of the mortar from the coarse aggregate should occur in handling the concrete or in finishing the surface.

In discussing the report of the committee on mixing and placing of concrete, Mr. Van Scoyoc, Toronto, mentioned that Mr. Davis, the engineer of tests on the Toronto-Hamilton highway, had devised a means of testing the consistency of concrete so that the proper consistency could readily be determined in the field. This method, he said, is comparable to the determination of normal consistency in cement testing. It is by means of dropping some of the concrete on a board placed at a certain angle; at one angle it will flow and at another angle it will not flow. A determination of the proper consistency by measuring the angle at which the mixed material will flow might be adopted as a means of definitely fixing that consistency.

William M. Kinney suggested that most of the failures of surfaces in concrete roads are due to too much water in the mixture. As the committee said in its report, too much water not only brings the cement to the surface, covering up the hard stone which give a good top wearing surface, but it also brings small sticks and other materials which wear out and leaves the surface pitted.

[Other Reports of Committees of the Second National Conference on Concrete Road Building will be presented in a later issue.]

At a recent meeting in New York the Committee on Warehouse Construction and Labor Saving Devices of the Warehouse Men's Assn. reported on the three methods of fireproof construction, structural steel, mill construction and reinforced concrete. The report showed that the initial cost of the last-named was not excessive; insurance rates and depreciation charges were lower, and greater cleanliness and safety were assured, when it was employed. Of the 503 separate warehouse buildings owned by the members of the Association, 156 were said to be fireproof, 244 non-fireproof, 32 sprinkled, with no reports on the other 71. Eighty % of the warehouses now being constructed are being built of reinforced concrete, the report claimed.

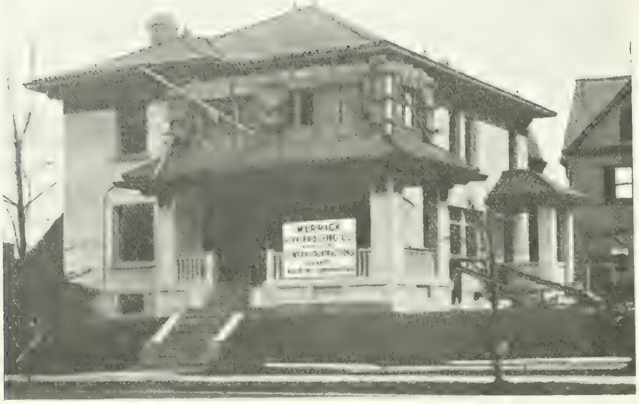


Fig. 1—Residence of Mrs. O. J. Stewart

A Concrete House with Tile-Lined Walls at Jersey City, N. J.

By Charles F. Dingman[1]

The concrete residence described differs from many houses, in that low cost was neither the first consideration nor the determining factor in the choice of a building material.

The owner demanded a residence which, for its size, should be strictly first-class and which should be fireproof, comfortable, permanent and gain its attractive appearance from harmonious proportions rather than from architectural embellishment. Concrete was pre-eminently the material indicated by these requirements.

The architect, George W. Von Arx,[2] has succeeded in producing a well proportioned, comfortable looking house without excessive adornment.

No attempt will be made to describe the interior finish beyond saying that everything is of a grade to correspond with the exterior.

The wall section shows the care taken to get a wall that should be damp-proof as well as a heat insulator. While this type of construction may seem excessively costly, it has been justified by the fact that in some places expensive paneled wood wainscot is placed against the wall and that the wall has proven an excellent heat and moisture insulator. The rods shown in the drawing were placed as an insurance against contraction cracks rather than to add strength.

The floor construction is of the Kahn hollow tile and concrete type.[3]

Cornices are of copper, to give a contrasting color, and the roofs are of red Spanish tile. The sleeping porch, shown unfinished in the illustration, has a glass roof set in puttyless sash, while the sides are made up of metal casements.

Practically all of the concrete work was cast in place except the porch balusters, which were cast on the ground and set in place, after which the coping rail was cast on top. The walls were poured in wood forms and are lined with hollow clay tile. All walls, after removing the forms, were ground to a surface as smooth as possible by the use of carborundum brick.[4] Forms were left on until the concrete was comparatively hard, which made the cost of surfacing reach the rather high price of 8 cts. per ft. However, it is believed that this cost was justified by the fine appearance of the surface obtained.

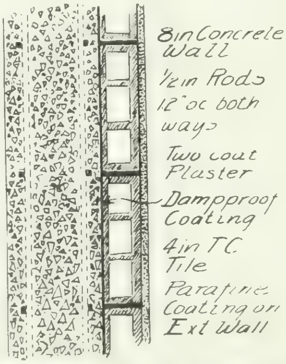


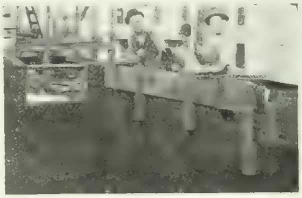
Fig. 2—Wall Section, Stewart House

The total cost of the house, excluding plumbing, heating, vacuum cleaner, electrical work and finished painting, was approximately 32 cts. per cu. ft., which is greater than the cost of a similar brick house, but considerably cheaper than a stone veneered house of the same style.

The house was erected for Mrs. O. J. Stewart by the Merrick Fireproofing Co.[5] Julius Bally was supt. of const. and the writer at that time was secy. of the contracting company.

Concrete Walls Built with Simple Form Equipment

A removable support for the sides of concrete forms has recently been patented by D. W. Daly.[6] As will be seen by the illustrations, the form boards, of which only two are used, are held in position by wood clamps which are tied to the wall by means of twisted wire secured to hooks which allow the boards to be readily detached, leaving the wire in the wall. In addition to these wooden supports, a light angle iron clamp is used on top of the form board to prevent spreading. This form is filled with concrete and then moved along the wall its length and again filled; by the time a course has been placed, the concrete is generally hard enough to allow another course to be made. A little ingenuity in the use of this little device will enable one to build corners without difficulty. Window frames can be set and concrete readily placed around them, as is shown by the illustration.



Simple Device for Holding Concrete Forms

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[1] Engr., Flynt Const. Co., Palmer, Mass.

[2] Jersey City, N. J.

[3] Trussed Concrete Co., Youngstown, Ohio

[4] The Carborundum Co., Niagara Falls, N. Y.

[5] N. Y. C.

[6] Parkersburg, W. Va.

A Double Wall Concrete House Economically Built in Cold Weather

By Carl W. Baumgardner[1]

Circumstances prevented work being started on the house which forms the subject of this article, until about the middle of Nov., 1914. Fair weather was experienced until Thanksgiving Day, when it grew colder and began to freeze. As the weather became colder we were forced to heat materials. By securing from a local junk shop a discarded tank, we made a very satisfactory heater, shown at Fig. 2, and, by using several coils of pipe, connected to the water supply inside the heater, had plenty of hot water.

Walls and partitions of the house are constructed with a hollow wall machine,[2] doing away with wall forms.

The floors are carried on 5-in. boiler tubes, over which was laid electric welded galvanized wire fencing and upon this was poured a 6-in. 1:2:4 cinder concrete rough floor. This floor was left in the rough until after the house was white-coated, when a terrazzo marble mosaic floor was laid.

Fig. 2—Improvised Heater for Aggregates

Fig. 3—Starting Construction Work

After the cinder concrete was hard enough to work upon, we built up the main walls of the house. From the plans it will be seen that the arrangement of the rooms wastes little space. The rear porch is enclosed with doors, sash glazed, and gives protection from heat and cold. Underneath the rear porch, the floor of which is a concrete slab with a manhole, is a 100-bbl. cistern. The arrangement of the cellar is very convenient. It is equipped with full set of plumbing, including hot and cold soft and city water at laundry tubs, electric connection for washing machine and drying room for clothes.

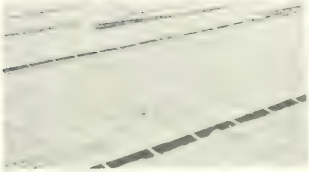

Fig. 4—Wire Mesh Ready for Concrete

Before applying plaster to the inside of the cistern the walls and floor were given two coats of Toco bond.[3] No dampness or seepage has appeared inside the cellar from the cistern.

The plaster is applied directly to the inside walls, the insulation pro-

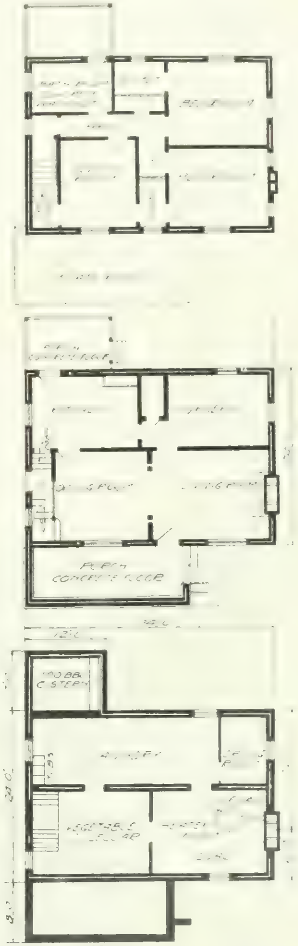

Fig. 6—Floor Plans, Baumgardner House

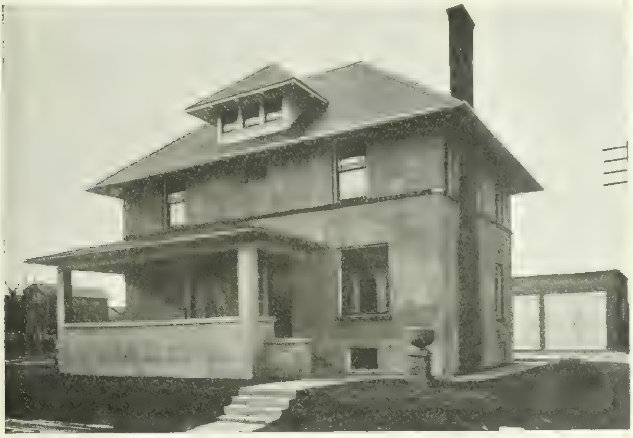

Fig. 1—Fireproof Residence, Tiffin, Ohio

vided by the 2-in. air space around the entire building making furring and lathing unnecessary. No dampness has penetrated to the inside walls. The amount of plaster used was about $^1/_4$ less than when placed on lath.

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[1] Baumgardner Concrete Products Co., Tiffin, Ohio

[2] Van Guilder Hollow Wall Co., Rochester, N. Y.

[3] Tropical Paint and Oil Co., Cleveland

The stucco finish was applied directly to the outside walls, the machine leaving a surface sufficiently rough to secure a good bond. The stucco consists of one smoothing coat of cement and lime mortar, over which was placed the finish coat of Medusa White[4] cement and marble dust,[5] applied with an automatic stucco machine.[6]

The partitions throughout are of reinforced concrete and the only things combustible about the house are the interior finish and the framing which carries the slate roof. There is a tapestry brick fireplace with ½-in. raked joints in the living room. Marble squares set at the time of laying the mosaic floors form the hearth. The house is heated by a 20th Century 24-in. grate hot air furnace[7] and has wall registers in every room.

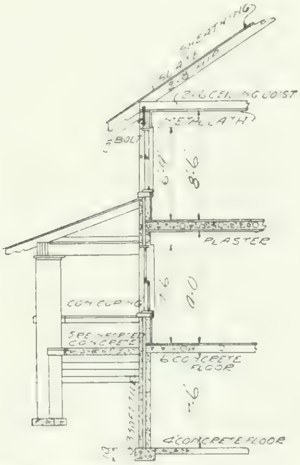

FIG. 6 SECTION OF WALL

The complete cost of the house is about $3,000, itemized as follows:

COST DATA

Labor—		
Digging cellar	$ 25.75	
Masonry and concrete day work	470.44	
Carpenter labor	501.18	
Plastering and lathing	90.60	$1,087.97
Materials—		
Reinforcing	57.06	
Cement, 150 lbs. @ $1.28 net	192.00	
135 tons No. 7 stone sand @ $1.10	148.50	
2,000 tapestry brick @ $20	40.00	
Sewer pipe	9.78	
Lumber and mill work	544.88	
Plumbing and fixtures	225.83	
Lath	38.50	
Plaster	19.60	
Slate roof (contract)	157.15	
Electric wiring and fixtures	90.00	
Hardware	38.54	
Nails	8.39	
Painting (contract)	85.00	
Marble mosaic floors	130.26	
20th Century furnace, installed	125.00	
Mantel, gas logs and andirons	29.00	1,919.43
		$3,007.40

Gun Carriages of Concrete

Every one who has made the famous gorge trip at Niagara Falls remembers the magnificent view from Brock's Monument at Queenston Heights in Queen Victoria Niagara Falls Park. At the base of the monument are five 6-in. ship's cannon bearing the mark of the old Scottish gun maker Carron and the date 1807. Doubtless this name was the source of the word carronade which was applied to ship's guns in the War of 1812.

It is interesting to note in passing that the notches on the back of the carriage served as bearings for hand spikes which were used to give the gun the proper elevation, at which it was held by the wedge shown under the breech, Fig. 2.

The passing of years had brought the sturdy oak carriages to an unsafe condition and bids were asked for their duplication. It was found that the expense of replacement in oak was almost prohibitive and Park Supt. John H. Jackson decided that the carriages could be made by using concrete, not only at a considerable saving in first cost but at a continued saving, due to low maintenance and permanence.

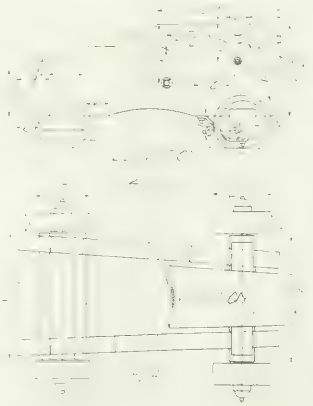

FIG. 1 DETAILS OF CONCRETE GUN CARRIAGES

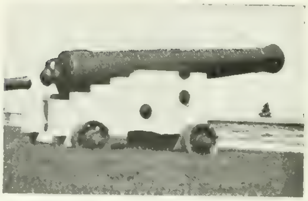

FIG. 2—CONCRETE GUN CARRIAGES AT BROCK'S MONUMENT, QUEEN VICTORIA PARK, NIAGARA FALLS, ONT.

The accompanying illustrations make the construction clear, details being given in Fig. 1 and a view of the completed carriage with the gun in place in Fig. 2.

This use of concrete is suggestive to those in charge of parks, where a little thought will often result in a saving in cost and in increased permanence. The concrete carriages are said to have cost slightly less than ½ the price quoted for oak.

Mortar For Joints Exposed to Currents of Water

In a discussion before the Boston Soc. of Civ. Engrs., John F. Howard[1] said:

> In building sea walls of coursed granite masonry laid in mortar and exposed to the action of tidal currents, where the bottom course is not more than 1' above mean low water, much difficulty is often encountered in holding the mortar in the joints long enough to give it time to set, as the action of the tides rising and falling on the fresh mortar will pull it out of place. It does not matter how rich a mixture is used, whether 1:1 or neat cement, it is impossible to keep the mortar in place until it hardens.
>
> On one piece of construction under the writer's supervision this difficulty was successfully overcome by mixing plaster of paris with the mortar in the proportion of 1 part of plaster of paris to 3 parts of 1:1 mortar. This mixture hardened within 5 min., and no further trouble was experienced from the mortar in the joints failing to set in place. The pointing of the joints in which this mixture had been used was entirely satisfactory.

In these days of concrete fence posts with their demonstrated economies and of telegraph poles of concrete with their permanence and stability, it seems strange that the concrete telegraph pole is not more rapidly superseding wood.

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[4] Sandusky Portland Cement Co., Cleveland

[5] Conlin & Co., Tuckahoe, N. Y.

[6] Automatic Stucco Machine Co., N. Y. C.

[7] 20th Century Heat. & Vent. Co., Akron, Ohio

[1] Asst. Engr., Directors of the Port of Boston

Concrete Coming Into General Use for Park Benches

Park benches, to take the place of wooden seats now in use, are being constructed by the Boston Park Dept., with reinforced concrete standards and oak slat seat and back. The upright, with horizontal seat support, is cast in one piece, and planted in the ground about half its height, which is 8′.

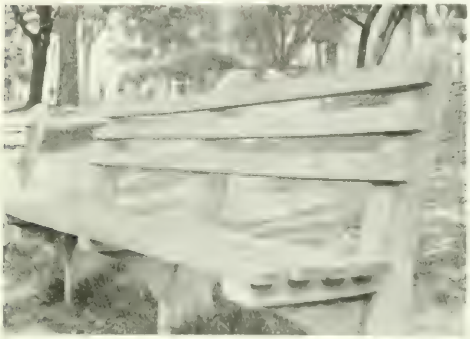


Fig. 1 Park Bench with Concrete Supports Sunk Into Ground, Seats of Oak; In Use in Boston

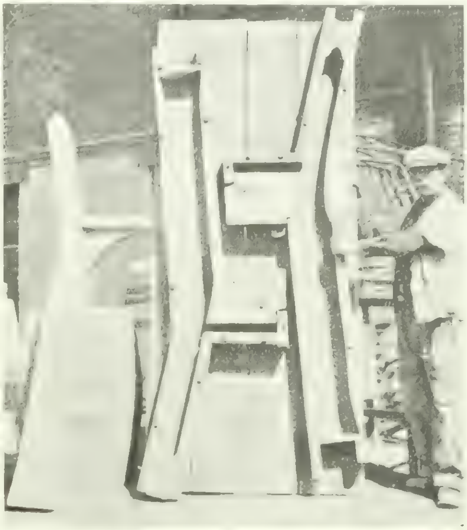


Fig. 2 Form Used in Making the Concrete Park Bench Standards in Boston — One of the Standards at the Left

The concrete parts are cast at the Park Dept.'s engineering headquarters in Franklin Park, Dorchester District, by workmen employed part of the time on the park grounds and on rainy days at this and other work, under shelter.

The dimensions of the structures shown in the accompanying illustrations are as follows: Height of frame, 8′; cross-section of lower half, 4″ x 5¾″; cross-section of upper portion, 4″ x 3¾″; length of horizontal seat support, 14″; thickness of horizontal seat support, 5″; thickness of bracket under support, 1½″. Reinforcing rods, of ¼-in. twisted steel, are embedded, one in each corner of the upright portion of the frame, two in the horizontal seat support and one in the bracket. The rods in the support enter the upright.

The mixture is 1 part white Portland cement, 1 of Ipswich sand and 1 of Plum Island sand, the sands being coarse and fine, respectively. Concrete is mixed by hand tools and placed, rather dry, in molds made of Southern pine joists and planking, the molds being made for casting two frames at once. Their sides are hinged, so as to strip easily. No outside finish is required after the casts have been made.

The forms are set in the ground to a depth of 4′ 3″. For the ordinary bench three frames, set 3′ 6″ apart, are joined by three oak slats for back and four slats for seat, 8′ long, and secured to the frame by galvanized iron bolts. Brass bolts were used at first, but many were lost by theft. The slats are 3¼″ x 1¼″, and the back slats are spaced 4½″ o. c. and the seat slats ½″ apart. On Boston Common a circular line of continuous seats is constructed, facing a grandstand. Several thousand standards are being made.

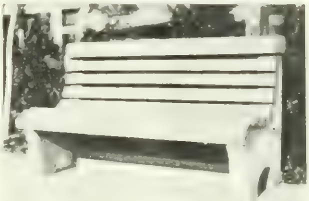


Fig. 3 Park Bench Used in Washington

Besides the casting of the bench frames, the Park Dept.'s men are engaged in casting a reinforced balustrade for the South Boston water front.

A different design of bench to set on top of ground or pavement is in use in Washington, D. C. They are in four pieces: top rail, bottom rail and two ends, as shown in Fig. 3. The parts are secured to each other by heavy bolts. The seat and the back are of heavy wood slats.

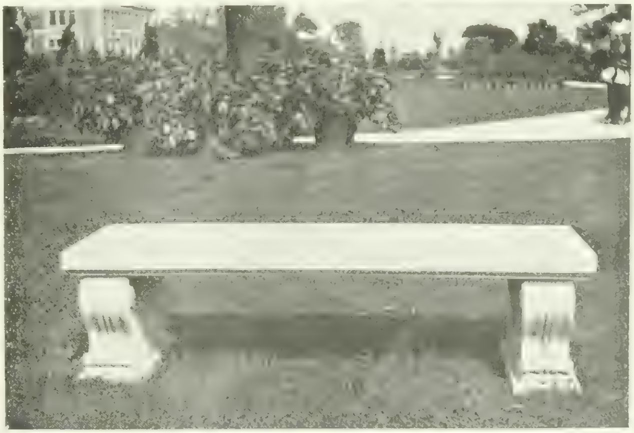


Fig. 4—All Concrete Seat in Grounds of O. C. Barber, Barberton, Ohio

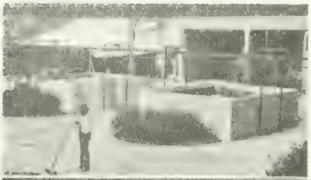


FIG. 1—CONCRETE STABLES, SHOP AND PAVED YARD

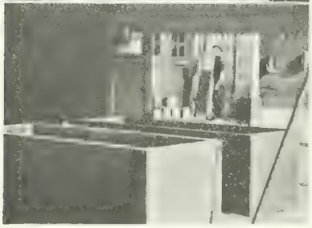


FIG. 2—BURIAL VAULTS AT GRACELAND CEMETERY

Concrete in Cemetery Improvements

BY H. COLIN CAMPBELL[1]

Graceland cemetery, Chicago, is one of the several city burial grounds that has found use for concrete construction, either to improve the cemetery proper or to increase in several ways the general working facilities. All of the concrete work thus far done, and there has been much of it, was performed by cemetery employees, working under proper supervision.

One of the most notable and extensive uses of concrete in the cemetery is shown in Fig. 1, which illustrates the stables, wagon sheds, work shops and cemetery work yards, which are below the level of the surrounding cemetery grounds and quite effectively hidden from view by trees and shrubbery. The work shop and stable yard are concrete paved. Two concrete manure pits are equipped with litter carrier to move stable refuse. Under and back of the awning in the view is one of the cemetery work shops, and here the employees conduct the incidental business of constructing concrete burial vaults, such as are illustrated in Fig. 2. A portion of the cemetery is enclosed with a concrete wall or panel fence, also illustrated, while the most recent use of concrete is exemplified in the automobile shelter shown in Fig. 4. This structure was designed by a well known firm of Chicago architects.[2]

In the accompanying plans, it will be noticed that this design depends upon the cantilever principle, and that the construction is unique. The shelter is intended primarily to protect the superintendent's car from the sun, and is not in any sense an enclosure. The drawing shows in detail how the design was worked out and the placing of reinforcing.

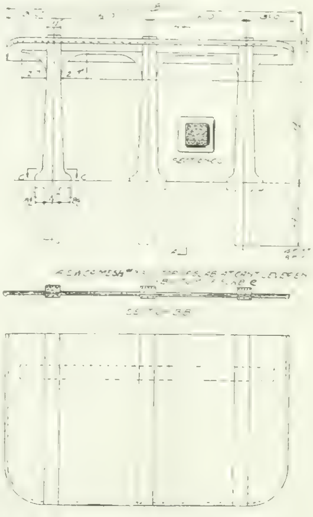


FIG. 5—ELEVATION AND TOP VIEW OF AUTO SHELTER

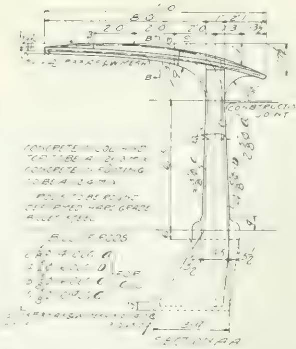


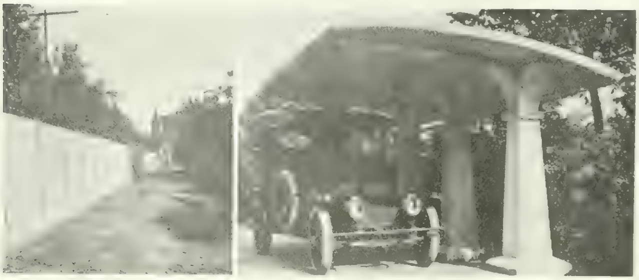
FIG. 6—DETAILS OF REINFORCING

Concrete mixtures at Graceland cemetery are well proportioned and properly placed. In the auto shelter a 1:2:4 mix was used for footings and a 1:1½:3 for columns. This little shelter suggests that the design might well be adapted without any considerable change to a roadside passanger shelter for interurban electric lines and would then, as in its present use, be both useful and ornamental.

While concrete is unattacked by tar or petroleum, fatty oils soon attack it, owing to the liberation of fatty acids as the oil becomes rancid. An article in *Il Cemento* deals with the means of making oil vats of concrete or reinforced concrete sufficiently resistant. A rich, well graded mixture must be used, the surface of which may be treated with silicates or fluosilicates. Also, as it is the lime of the cement which reacts with the acids, the addition of 20% of finely ground puzzolan is of great advantage. Experiments on this point have been made by Prof. Canevazzi, who finds that such an addition confines the action of the acid to an insignificant surface layer. Many of the large underground reservoirs for olive oil in Italy have, however, been lined with slabs of Marseilles red ware cemented together by clay of the same kind as that used for the slabs. These have given good results.

In a recent publication of the Portland Cement Assn., the following table showing the mileage of concrete roads and the percentage of total roads contracted for by the Ohio State Highway Dept. since 1910 is printed:

Year	Concrete Mileage	Percentage Total Mileage Contracted
1910	1.49	2.1
1911	1.25	2.1
1912	40.39	26.1
1913	22.30	14.2
1914	130.69	25.8
1915	48.54	13.0



FIGS. 3 AND 4—CONCRETE FENCE AND AUTOMOBILE SHELTER

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[1] Engr., Chicago

[2] Holabird & Roche

Twelfth Annual Convention of the American Concrete Institute

The 12th annual convention of the American Concrete Institute was opened by President Wason at the Auditorium hotel, Chicago, Monday morning, Feb. 14. To expedite the presentation of the very full program provided, speakers were limited to 25 minutes and individual discussions to 5 minutes each, with a total time for reading and discussion of 45 minutes.

CONCRETE ON THE MASSACHUSETTS STATE FARM

The first paper presented, "Concrete on the Massachusetts State Farm," was read by the author, Arthur J. Maynard[1], and illustrated by lantern slides. The Massachusetts institution was one of the first to take up the use of concrete and its work dates from 1893. In general the construction used for buildings consists of monolithic hollow walls, produced by the use of cores which are pulled as the work proceeds. It was explained that the use of curved bays on large buildings serves to take up expansion and contraction so that no cracks have resulted.

Reference was made to flat slab construction covering a well 75′ in diameter which has been mentioned often in discussions of early flat slab floor construction. The slab is 5″ thick, reinforced with expanded metal and was constructed in 1900. It is believed that this slab antedates the earliest flat slab patent.

In the discussion President Wason spoke of a bake oven at the institution constructed with crushed fire brick as an aggregate. He stated that the oven walls are frequently red hot, yet the concrete has remained in excellent condition after a number of years' use. It was suggested that this material might be of considerable value for fireproofing purposes.

RELINING A TUNNEL WITH STEAM-JETTED CONCRETE

The second paper was presented by Harold P. Brown[2] on "Relining a Tunnel with Steam-Jetted Concrete." This paper presents the solution of the problem of lining an old tunnel which was originally lined with timber and afterwards relined with brick. The brick had disintegrated in the course of time until the tunnel had become unsafe. A very small clearance was available and it was necessary to reline the tunnel between the passage of trains with only about 6 hrs. per da. available for work.

The work was accomplished by means of a train equipped with air compressors, steam pump and dynamo for electric lighting. A concrete atomizer was used and the concrete was blown against the brick lining, which had been previously cleaned by scrubbing and steam jetting at a pressure of 90 lbs. per sq. in. It was found necessary to arrange for mechanical control of the nozzle and a special nozzle and troweling machine were devised which were carried on a second car. The mixture was 1 cement, 3 sand and 2 pebbles, used with 10% of water. The concrete was carried through a 2-in. hose and shot onto the brick by steam jets. Mortar was forced into intimate contact with brick work and very little material rebounded.

In some places a layer of concrete 7″ thick was used. In the final layer, hydrated lime was used and the pebbles were omitted. The mixture was proportioned, 1 hydrated lime, 10 cement and 30 sand. No reinforcement was used. Three coats totaling an average of 3″ to 4″ thick were placed and trimmed to arcs of 9′, 12′ and 16′, respectively. It was found possible to apply one coat to 262 lin. ft. 12′ wide per day of 6 hrs. This required about 35 bags of cement. The work was completed in 41 das.

In the discussion which followed it was brought out that steam-jetted concrete used for a levee slab, 2″ thick, was equal by test to a 5-in. poured concrete slab of the same proportion. The addition of hydrated lime was said to prevent too rapid setting. The cost for fuel and labor on ordinary work is said to be from 50 cts. to 55 cts. per cu. yd. which could on large jobs be reduced to 30 cts. or 32 cts. per cu. yd.

A paper on "Swimming Pools," by Edward D. Boyer[3] was not read as the author found that the subject was so large that it seemed best to defer presentation until it could be more fully covered.

NOVEL FEATURES OF CONCRETE WORK ON THE NEW YORK SUBWAY

A paper on "Novel Features of Concrete Work on the New York Subway," was read in the absence of the author, Robert Ridgway[4], by E. J. Mehren[5]. Because of the short time available only portions of the paper were read, which were illustrated by slides. A novel method of using concrete in cold weather was shown, consisting of introducing into the mixer a large flame such as is produced by blowing gas with compressed air. This method was found very effective and economical. One of the features of this paper was an account of a discovery of old concrete foundations, some of which had been placed under water by means of bags, filled with concrete, the outlines of which are still visible. Some of this concrete, while apparently not of the best, has been tested and shows strength of 4,000 lbs. per sq. in.

REPORT OF COMMITTEE ON NOMENCLATURE

The report of the committee on Nomenclature occupied considerable time without definite results. The report was laid on the table with the recommendation that an attempt be made to get a number of the technical societies to select a joint committee on Nemonclature.

UNIT COSTS IN CONSTRUCTION

The evening session opened with a paper by Sanford E. Thompson[6], which was read by the Institute Secretary, Mr. Goodell. This paper, a discussion of estimating based on accurate knowledge of unit costs, is presented elsewhere in this issue.

NEW STANDARD CONTRACT DOCUMENT

The interpretation of the new Standard Contract Documents was to have been given by H. L. Lewman[7], and in his absence the subject was discussed briefly by Lewis R. Ferguson[8]. The documents are a second edition of the Standard Contract Form of the American Institute of Architects, designed to remove causes for dissatisfaction between architects and contractors and to provide means of arbitration.

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[1] Supt. Const., Mass. State Farm, Bridgewater, Mass.

[2] Consult. Engr., N. Y. C.

[3] Cement Expert, Atlas Portland Cement Co., N. Y. C.

[4] Engr. of Subway Const., N. Y. C.

[5] Editor, *Engineering Record*.

[6] Consult. Engr., Boston

[7] Pres., Nat. Assoc. Bldrs. Exchanges, Louisville, Ky.

[8] Portland Cement Assn.

REPORT OF COMMITTEE ON INSURANCE

Instead of a committee report, a letter was read from J. P. H. Perry,[9] chairman, containing recommendations for the coming year. Mr. Perry believes that this committee should collect data on fires in reinforced concrete buildings to form a basis on which insurance rates can be based. Mr. Wig[10] stated that such data are in his possession and available up to the year 1905.

The committee on Building Blocks and Cement Products presented a report through its chairman, Robert F. Havlik[11], consisting of suggested specifications intended for adoption in the building codes of various cities to regulate the use of concrete building units. Inasmuch however as the bylaws of the Institute require that specifications of this kind be presented to members 30 das. in advance of the convention the report was received and filed and nothing will be done about it for another year, when the members will be given an opportunity to read it in advance of the convention in order to discuss it at the next meeting.

REPORT OF COMMITTEE ON SIDEWALKS AND FLOORS

Chairman Lewis R. Ferguson presented a progress report of the committee on Sidewalks and Floors which was printed and distributed. This committee has been organized recently and the report suggested procedure and that it would be advisable to consider combining the committee on Concrete Roadways and the committee on Sidewalks and Floors, dividing the work of such a combined committee into sub-committees.

BUSINESS SESSION

At the business session officers for the ensuing year were elected, as follows: Pres., Leonard C. Wason, Boston; vice-pres., Henry C. Turner, New York; treas., Robert W. Lesley, Philadelphia. The directors are: Charles R. Gow, Boston; Edward D. Boyer, New York; J. G. Trenor, California. Pres. Wason announced the discontinuance of the monthly *Journal*. Bulletins will be issued from time to time. The office at Philadelphia will be given up and President Wason has donated office space and clerical expense for the coming year. The offices will, therefore, be removed to Boston. He called attention to the services of Mr. Goodell, who had acted as secretary without pay for several months. Mr. Goodell was tendered a rising vote of thanks by those present. Following Mr. Wason's statement, the treasurer, Robert W. Lesley, presented the financial report of the Institute, which was accepted.

REPORT OF COMMITTEE ON REINFORCED CONCRETE AND BUILDING LAWS

The report of the committee on Reinforced Concrete and Building Laws was read by Chairman E. J. Moore[12]. It is hoped that this committee will succeed in getting its report in such form that when balloted on by letter 30 das. before the next annual convention it will be accepted and exert a wholesome influence in leveling off the radical differences of the various city building codes. Too many differences exist at present to permit the most economical design of concrete structures and a universal (or as nearly so as is possible) code seems the only solution.

After reading the report proper, Mr. Moore discussed some details of recommended practice, with the aid of lantern slides. These consisted of a suggested detail for anchoring stirrups in beams by bending down the upper ends of stirrups over light longitudinal bars laid upon the transverse slab bars in top of slab over beam, and common practice and test data on columns. In connection with the discussion on stirrup anchorage, Prof. A. N. Talbot[13] stated that in his opinion the stirrups in the ends of continuous beams should be as securely anchored to the top or tension reinforcement as they are to the bottom reinforcement. W. P. Anderson[14] stated that in his opinion stirrups should be replaced by bent bars which are in a much better position to take up diagonal tension stresses than stirrups, when properly embedded in top and bottom of the beam.

In commenting on column shapes Mr. Moore stated that for architectural reasons and in the light of recent experience with the behavior of concrete columns in fires, the round column seems to come nearer being the ideal interior column than any other shape. Slides were shown giving graphically the results of the Pittsburgh tests of the Institute.

Rhudolph J. Wig[15] raised an objection to the section of the report recommending that concrete be proportioned to secure the maximum density, his contention being that such a mixture was too stony, with insufficient sand to insure the proper covering of reinforcing.

The specification of rivet steel for column spirals was objected to by several members on the basis that this grade is hard to get and furthermore is little used for reinforcing. Mr. Morgan[16] suggested that since cold drawn wire is mostly used for hoops and spirals it be substituted for rivet steel and the requirements for cold twisted bars be used until specification is adopted.

Prof. Talbot called attention to the fact that the committee recommendations were not in accordance with tests and suggested that the matter be referred back to the committee. It was also suggested that the report be so modified as to allow the use of retempered concrete, under certain conditions.

Owing to lack of time the discussion was limited and the report accepted as a progress report.

REINFORCED CONCRETE COLUMNS

"Reinforced Concrete Columns," a paper printed in advance, was read by title in the absence of the author, P. P. Furber.[17] The author holds that the reason for the extensive use of columns reinforced with vertical rods and occasional ties or stays, even though columns vertically and spirally reinforced are generally considered better design, is that this inferior construction is lower in cost than the hooped column, when designed in accordance with most building ordinances. He says:

> Many building ordinances place a premium on this dangerous construction by allowing higher relative stresses on the concrete of such columns than on spirally reinforced columns, when we consider the increase in ultimate strength of the latter. Some have gone so far as to permit as great unit pressure on the concrete of a column without hooping, as on a well designed hooped column. * * * The result of such building laws are obvious. Designers will use the cheaper type, except in some cases where it may be possible to control the design of the work with regard to actual strength secured in the structure rather than with a view to meeting the requirements of some building department. * *
>
> Most of the failures of concrete structures have occurred in buildings designed so that the figured unit stresses were not too high when judged by ordinance re-

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[9] Mgr., Contract Dept., Turner Const. Co., N. Y. C.

[10] U. S. Bur. of Standards, Washington, D. C.

[11] Mooseheart, Ill.

[12] Chf. Engr., Turner Const. Co., N. Y. C.

[13] University of Illinois, Urbana, Ill.

[14] Pres., Ferro-Concrete Const. Co., Cincinnati

[15] U. S. Bur. of Standards, Washington, D. C.

[16] Engr., Robt. W. Hunt & Co.

[17] Res. Engr., C. A. P. Turner, Chicago

quirements, and the failures have been due to failures of the type of member rather than of the material. A large number can be blamed on the use of columns without hooping. On the other hand, the author at least, has never heard of a failure of a hooped column in a building. The continued service of hooped columns under pressures, which, according to some building laws, would be considered dangerous, leads one to believe that something is wrong with the building laws, particularly when reliable column tests indicate that the stresses allowed are conservative.

A table giving the requirements of 43 different building regulations and authorities regarding reinforced concrete columns is of special interest since it shows some very marked differences in requirements and without question points out a crying need for revision of a large part of the present laws. This is especially true when it is considered that many of the ordinance values do not correspond with values determined from tests.

Numerous tables are given in the paper comparing load-carrying capacity, etc., as allowed by various ordinances, which merit careful study. Mr. Furber in closing says:

> The specification of reasonable values for reinforced concrete hooped columns will tend to the increase of fireproof construction and a corresponding reduction of inflammable timber construction, because the difference in cost between scientifically designed concrete construction and well designed timber mill construction will be small in the ordinary warehouse or factory building. On a big job concrete frequently will be cheaper. Many times, the cost is prohibitive under the present conditions. The writer does not advocate using high stresses merely to reduce cost, but he does believe that it is time for building departments and framers of ordinances to recognize the true strength of hooped columns and to provide laws which will permit reasonable stresses in such members.

DESIGN OF CONCRETE BUILDING

W. P. Anderson[14], presented a paper on the "Design of Concrete Buildings," which dealt mainly with observations of the behavior of actual buildings of the beam and girder type under test loads, and the results of tests on special test beams and pieces. He mentioned that lack of attention to practical details by designers is responsible for many uneconomical designs.

Tests made on continuous beams by Mr. Anderson indicate that the stresses in the top reinforcing over supports are not so high as provided for in ordinary design.

Results of "pull out" and "push out" bond tests on bars embedded in concrete blocks were presented. These showed that the bond resistance in "push out" tests was greater than in tests where an attempt was made to pull the bar from the concrete, due no doubt to the tendency of the bar to enlarge under compressive stress and the bearing on the end of the bar.

CONSTRUCTION OF FLAT SLAB FLOORS

A popular paper entitled "Construction of Flat Slab Floors," illustrated with a large number of slides, was presented by Alfred E. Lindau[18]. This paper, presented in an impartial manner, created considerable interest, illustrating as it did, practically all forms of flat slab construction and steps in the early development of the art of flat slab design. That flat slabs can withstand, without distress and little deflection, loads very much in excess of the designing load, was evidenced by the many test-load photographs presented. The adaptability of flat slabs and their numerous alvantages were clearly illustrated by photographs and diagrams.

GENESIS OF REINFORCED CONCRETE CONSTRUCTION

"Genesis of Reinforced Concrete Construction" was the title of an historical paper by Prof. W. K. Hatt[19], dealing with early literature on concrete construction and examples of early construction. Prof. Hatt illustrated very clearly by means of a diagram thrown on the screen the slow progress in literature of reinforced concrete made from 1870 to 1890 and the rapid strides made from that time up to 1900, when over 300 titles were listed.

One of the most interesting slides shown was that of a reinforced concrete roof slab of 20-ft. span and 12-in. thickness, built by Coignet, in France, in 1852, which was in good condition in 1910. Other noteworthy dates mentioned were: 1861—Coignet's book, the first on the subject of concrete, published; 1871—a reinforced concrete arch of 50-ft. span with skeleton frame built at Ipswich; 1877—Hyatt's book, the first attempt at arriving at a theoretical basis of design for reinforced concrete, published; 1889—reinforced concrete arch built at Golden Gate Park, San Francisco; 1892—the first monthly concrete journal appeared in France; 1894—sawtooth roof construction of ooncrete used on a factory in France; 1902—*Beton u. Eisen,* the famous German publication on concrete, made its first appearance.

Prof. Hatt rendered a glowing tribute to the early experimenters to whom we owe much for our present status in concrete design and construction. Present-day theorists are very likely to underestimate the value of the works of the early constructors, but their many works stand as witness to the skill of the men engaged in concrete construction prior to 1900.

A FURTHER DISCUSSION OF THE STEEL STRESSES IN FLAT SLAB FLOORS

In the absence of Prof. H. T. Eddy his paper, "A Further Discussion of the Steel Stresses in Flat Slab Floors" was presented by A. L. Johnson, who read only small portions of the paper, it having been printed and distributed in advance of the convention. This gave opportunity for the preparation of several discussions which took pronounced exception to some of Prof. Eddy's statements.

THEORY AND TESTS OF FLAT SLABS

Edward Smulski, consulting engineer, Boston, read a paper on "Theory and Tests of Flat Slabs," descriptive of his system of radial, circular and direct reinforcement for flat slabs[20]. The results of a test on a panel of this type were given, as well as those of tests on circular cantilever slabs from which the author has deduced to his own satisfaction that radial and circumferential reinforcing is more effective than straight bars.

DESIGN OF REINFORCED CONCRETE FOUNDATIONS

"Design of Reinforced Concrete Foundations for Buildings," by R. L. Berlin[21], was presented by title and accepted without discussion. The paper was a plea for the general acceptance of the methods of designing footings proposed by Prof. A. N. Talbot in *Bulletin* No. 67 of the University of Illinois, Engr. Exp. Sta., in order to eliminate the wide differences in methods of design.

REPORT OF COMMITTEE ON FIREPROOFING

The report of the committee on Fireproofing, chairman Maj. John S. Sewell, was read in the absence of the chairman by Secretary Goodell. In brief the report stated that as a result of tests under way the committee hoped to draw up specifications for fireproofing which would set a very high standard since members of the committee feel it very necessary that good practice be clearly defined. The committee asked to be continued and its report was accordingly accepted as a progress report.

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[18] Mgr., Corrugated Bar Co., Chicago

[19] Purdue University, Lafayette, Ind.

[20] See p. 133, Oct., 1915, issue CONCRETE

[21] Engr., Maynicke & Franke, N. Y. C.

REPORT OF COMMITTEE ON CONCRETE SURFACES

Cloyd M. Chapman[22], as chairman of the committee on Treatment of Concrete Surfaces, read a progress report and commented upon some suggested amendments to be balloted upon before the next convention. Mr. Chapman told of the tests now being made by the Bur. of Standards, Washington, D. C., from which it is hoped that some very valuable data as to concrete surfaces will be obtained. The meeting closed with a discussion on cracks in stucco.

TESTS SHOWING CONTINUED DEFORMATION UNDER CONSTANT LOAD

"Tests Showing Continued Deformation Under Constant Load" was the title of a paper by Prof. A. H. Fuller[23] and Prof. C. C. More[23]. Prof. A. B. McMillan, University of Minnesota, read this paper and in addition presented data on similar tests made by him which showed that shrinkage of concrete exerts an influence in reducing the apparent tensile stress in the reinforcement of beams and slabs. The following brief summary of the paper is of interest.

In making a recent test (Apr., 1915) of a reinforced concrete building it was found that the concrete deformations in the building greatly exceeded those in laboratory tests under unit stresses presumably approximately the same. It was also found that the deformations in the building increased during the few days that the maximum test load was allowed to remain. It seemed probable, therefore, that the time element should be considered in interpreting the stresses, but no literature was found giving data on the subject.

Use was then made of three available compression specimens in applying increments of load at intervals of 24 hrs. at approximately the same rate as in the building. The accompanying diagram (Fig. 1) shows the relation between days under load and deformation during the periods that the specimens were under constant load.

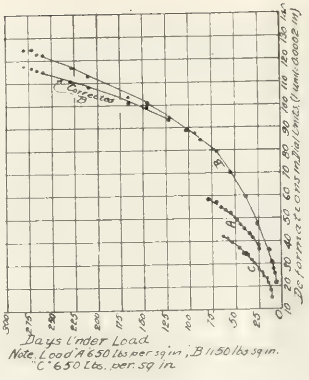

Fig. 1

It seems apparent that the modulus of elasticity as a measure of the relation of stress to deformation while the load is being applied or released is of doubtful value in determining the stresses that are represented by observed deformations in concrete that has been under load for a considerable period of time. However, the modulus of elasticity as a measure of the relation of stress to deformation as determined from time tests in which the rate of application is the same would furnish means for making a fairly satisfactory determination of the existing stresses. Thus in Fig. 2, an average line has been drawn through the points showing the deformations twenty-four hours after each load was applied, and the modulus of elasticity corresponding to each of these lines has been noted. These moduli will serve as a basis for determining stresses within corresponding deformations and days. They will doubtless give results in excess of actual stresses for deformations greater than those observed.

It is realized that these tests are inadequate for use other than on the building in question. It is believed, however, that they indicate that the plasticity of concrete must be recognized and distribution of stress between steel and concrete in reinforced concrete structures may be quite different from that usually assumed.

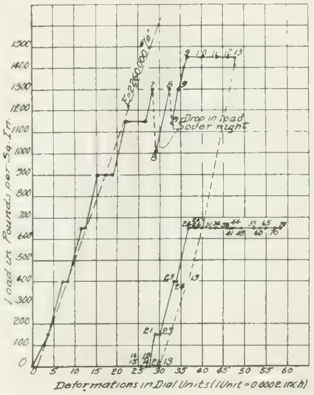

Fig. 2

Following this Carl B. Smith[24] presented a paper along the same lines entitled "The Flow of Concrete Under Sustained Load," which verified the contentions set forth in the previous paper. Mr. Smith concludes that:

> "The deformation of concrete due to stress contains two factors, one which is probably somewhat elastic and the other a molecular displacement or flow; the magnitude of the flow factor is dependent upon the time.
>
> The determination of stress values in concrete structures from the deformations of the concrete is rather questionable and entirely dependent upon the time factor. Stress values obtained from initial deformations, within only a few minutes after the application of the load, are probably more nearly true than later determinations. * * * The effect of flow in most cases is to change or relieve the stress value; where this is impossible there is a gradual change in the length of the member, continuing possibly for several weeks. * * *
>
> In the case of a concrete beam with anchored or fixed ends, the temperature stresses are supposed to be very large; but since the temperature expansion is slow, there is time for flow to occur and thus relieve the stress. The amount of relief may be from 25% to 80% of the computed temperature stress, depending upon the relative magnitude of the stress and the time factor. * * * *
>
> This phenomenon of the flow of concrete may explain the abnormal stress conditions which apparently exist in some structures, such as concrete roads, pavements and arches. The subject, however, needs much investigation to establish its exact effect and magnitude, before it should be considered as a factor in design.

THE INFLUENCE OF TEMPERATURE ON THE STRENGTH OF CONCRETE

"The Influence of Temperature on the Strength of Concrete" was the title of a paper by Prof. A. B. McDaniel.[25] This paper, having been printed for distribution before the meeting, was not read but the author gave a brief talk on the subject. The conclusions drawn by Professor McDaniel are briefly:

1. Under uniform temperature conditions there was an increase in strength with age within the time limits of the tests.

2. It is evident that if the concrete is to acquire a reasonable self-sustaining or a load-bearing strength in a short time (conditions which ordinarily obtain in building work), it is necessary to place the concrete under the most favorable conditions

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[22] Engr. of Tests, Westinghouse, Church, Kerr & Co., N. Y. C.

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[25] University of Illinois

and maintain these conditions during the first few days. Concrete which is protected and maintained at a temperature of from 60° F. to 70° F. will at the age of one week have practically double the strength of the same material which is kept unprotected at a low temperature of from 32° F. to 40° F. Under freezing temperature conditions the materials should be heated so that the concrete will have an average temperature of from 60° F. to 70° F. and the concrete in place kept under an air temperature of not less than 45° F. by artificial heat during the first week. This provision for favorable temperature conditions avoids the well known injurious effect of the freezing of the water in the concrete, and also the deteriorating effect of the alternate freezing and thawing of the concrete.

TESTS ON CONCRETE COLUMNS, PLAIN AND REINFORCED

A paper entitled "Tests on Concrete Columns, Plain and Reinforced," by Prof. F. P. McKibben[26] and E. S. Merrill,[27] was presented briefly by E. J. Moore, advance copies having been distributed. There was no discussion of this paper.

The tests showed that for plain columns 5′ long, 14″ in diam. and 8-in. x 16-in. cylinders the average compressive strengths were very nearly equal, while the strengths of 10-ft. and 20-ft. columns are approximately equal, amounting to 81% of the strength of cylinders. Under axial compression the diameter of a column is increased and its length decreased. This swelling, resulting from longitudinal compression, is, under low unit loads, much less than the unit longitudinal deformation, that is, Poisson's ratio increases as the unit longitudinal deformation increases.

Tests on reinforced columns indicated that: Spiral reinforcement increases the ultimate strength, practically in proportion to the percentage of spirals until 1% is reached. For percentages larger than 1, the rate of increase is not so great. For unit compressive stresses under 2,500 lbs. per sq. in. longitudinal deformations are only very slightly affected by spiral reinforcement, but under large unit compressive stresses the spirals restrain the lateral swelling of the concrete, hence, retard the longitudinal deformations. For spirally reinforced columns the effect of increasing the vertical steel is to decrease the longitudinal deformation, because the modulus of elasticity of vertical steel is materially greater than the modulus of elasticity of the concrete; an increase of vertical steel also decreases the lateral deformation. The results of these tests indicate that vertical steel increases the ultimate strength and that the greater the percentages of vertical steel the greater the ultimate strength. This applies only to columns in which the vertical rods are properly supported against buckling.

POSSIBILITIES OF SPEED ON HIGH BUILDINGS WITH UNIT CONSTRUCTION

Charles W. Watson[28] read a most interesting illustrated paper on the "Possibilities of Speed on High Buildings with Unit Concrete Construction." The construction methods used in the erection of the superstructure of an eight-story cold storage building in six weeks were told. The building consisted of structural steel columns and girders supporting pre-cast beams and slabs, the placing of concrete members following so closely behind the steel erectors that no temporary plank floors were laid on the steel, as is usually the case in high steel frame construction.

The beams and slabs were cast in steel forms in a nearby yard while the foundations, which presented numerous difficulties, were being put in. The cost of formwork for these members, based on using forms for at least three jobs, was 2 cts. per sq. ft., a remarkably low figure.

After the steel frame for a floor had been completed the concrete floor beams were placed by steel erectors, the derricks raised and the laying of the sectional floor slabs 2″ thick begun. These were laid in a mortar bed on ledges provided on the beams after the steel beams between columns were encased in concrete, thus securing the ends of floor beams.

The speed of erection attained is believed to be a record in cold storage building construction, the floors being put into use on an average of 30 das. after completion.

TESTS OF REINFORCED CONCRETE

"Tests of Reinforced Concrete," by Burtis S. Brown[29], was the subject of a paper illustrating the results of tests on flat slab test panels with different shaped column heads and arrangement of reinforcing. In the absence of the author the results of the tests were explained by W. A. Slater, who conducted the tests.

The test structure, one story high, consisted of 16 panels of four-way reinforced slab with column capitals of different sizes and shapes and four distinct types of reinforcement. The edges of the slab were flush with the outside face of exterior columns, a condition tending to throw considerable bending in the columns under the test load.

The deformation and stress readings shown by diagrams were of much interest, the diagram for stress in steel over the column head showing a very sudden drop in stress in the vicinity of the edge of the capital, indicating a sudden change in bond stress which must be properly taken care of in design. This condition was no doubt aggravated by the unusually thick plate surmounting the column head.

Failure took place in one corner group of panels with small column capitals, due to excessive tension in the reinforcement, and was hastened by excessive bending in exterior columns. The fact that the other portion of the test structure did not fail under the same load is explained by the larger column capitals under the slab. An interesting point disclosed by the photographs shown was that the failure was not sudden but a gradual progressive breaking down of the slab over columns.

REPORT OF COMMITTEES ON REINFORCED BRIDGES AND CULVERTS

One of the longest and most complete reports presented at the convention was the preliminary report of the committee on Reinforced Bridges and Culverts. This was read in part by the chairman, C. B. McCullough[30].

The purpose of the report is stated to be:

1st. To promote interest and discussion of the subject.

2nd. To promote better design and construction methods and to eliminate failure in concrete highway bridge work.

The report is so well arranged and so complete that it can hardly fail to serve its purpose. The following abstracts from the concise summary given at the beginning of the report give some idea of its importance and scope.

Preliminary Investigation. 1. No plans should be sent out for bridges based on reports of unskilled local officials.

2. Skilled engineers or those especially trained should make the study of the bridge site.

3. Bridge departments should issue blank forms listing in detail all the information that the field engineer should procure.

4. The exact wording of the form to be decided upon by each individual organization.

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[26] Lehigh University

[27] Asst. to Chf. Engr., Turner Const. Co.

[28] Contracting Engr., Philadelphia

[29] Consult. Engr., Boston

[30] Designing Engr., Iowa State Highway Commission

5. A thorough knowledge of the behavior of streams is necessary before a proper report on the bridge site can be made.

Selection of Type of Structure.—1. The selection of the type of structure is influenced by a large number of local conditions and can be properly made only after study. In general, the following laws regarding selection will hold.

(a) The slab is well adapted for spans of from 16′ to 25′ where simplicity is desirable, and where the head room is low, for multiple span construction where low pier heights or foundation conditions render this type economical, and for locations near natural deposits of concrete materials.

(b) The through girder is adapted for spans of from 20′ or 24′ up to 50′ or 60′ where not to exceed 20-ft. roadways are required, where the head room is low, and where a massive architectural treatment is desired.

(c) The deck girder is adapted to spans of from 20′ to 24′ up to 50′ or 60′ where head room is not limited and to any width of roadway; especially adapted to viaduct construction where the greatest economy is desired. This type is susceptible of ornamental, architectural treatment.

(d) The arch type is adapted for long span construction, for construction over excessively high openings where the cost of abutments and piers for multiple short span girders or slabs would be prohibitive, where clear spans longer than 50′ or 60′ are necessary, and for construction carrying extra heavy traffic loadings. Arches are not to be recommended except for the very best of foundation conditions. This type is particularly adapted for locations where beauty of outline is demanded.

Bridge Loadings.—1. Accurate measurements should be made to determine the weight of filling material since considerable variation in stress may result from a variation in weight of earth fill.

2. A knowledge of traffic conditions is necessary to determine the safe and economical load that a bridge is to carry.

3. Bridges should be classified as to loads they are to carry.

4. Pending experimental data on the distribution of live load concentrations through fills, it is recommended that the most conservative practice be adopted in this regard.

Details of Design.—1. The slab type is the simplest of all types in design, but a further investigation of the lateral distribution of load concentrations should be made. This problem is being investigated at a number of experimental stations.

2. The through girder type presents more complications in design. Further investigations are necessary to determine the position of the neutral axis for different conditions of loading, to determine the best distribution of the reinforcement and to settle other questions as discussed on a following page.

3. The deck girder type is more complicated in design than either of the foregoing; the chief point in doubt being the width of floor, also which may be considered as acting with the girder as a part of the T-beam. The safe value which may be assumed for this width must obviously be determined by further tests but our present knowledge would recommend an assumed total width not to exceed 75% of the distance center to center of girders, nor should it preferably exceed six times the width of the girder stem, nor eight times the thickness of the floor slab.

Special precaution should be taken to provide ample reinforcement for the girders, which reinforcement should preferably be proportioned to take the entire diagonal tension, assuming that none of this stress is borne by the concrete.

The reinforcement in the lower side of the floor should be made continuous over the girders.

4. In the design of arches, stresses arising from the lateral movement of foundations may greatly increase the stresses in the superstructure. For this reason, the use of this type should be restricted to those locations where the best foundations may be secured.

Reinforced arches should be proportioned to withstand stresses induced by a variation in temperature, given by the formula:

$$Y = 90^\circ - .53X$$

where "Y" is the range in degrees F. and "X" may be taken as ½ the average thickness of the arch ring. Where the yearly range of air temperature is less than 135° F., this value may be somewhat decreased.

The effect of axial compression or rib shortening may considerably modify the stress values and should be taken into account in the design of this type.

Reinforced arches should be provided with reinforcement throughout the entire arch ring, along both the intrados and the extrados of the arch.

Vertical expansion joints are necessary where the spandrel walls join the abutment wing walls at the piers and at one or more points over the arch ring, depending on its length.

5. Substructure design.

(a) Until further experimental data are available, the pressure to be assumed for back filling should not be less than that due to a fluid weighing 25 lbs. per cubic ft. This value is to be increased if the filling is liable to be saturated.

(b) Special precautions should be taken to secure drainage of the back filling material.

(c) Bearing power tests of foundations should be made for all structures of any considerable size. In general, wherever piles can be readily driven, they should be used.

(d) If the character of the strata underlying the foundation is such as to necessitate the use of very short piles, the foundation should probably be carried deeper rather than piled.

At the Wednesday afternoon session, the first paper presented was "Difficult Foundation Work on the Bay of Fundy" by N. M. Loney[31]. No discussion was brought out in connection with this paper.

FORMS FOR CONCRETE WORK

The second paper, entitled, "Forms for Concrete Work," by R. A. Sherwin[32], was printed in advance and discusses methods employed by the Aberthaw Construction Co., Boston. Mr. Sherwin states that the form cost is $18\frac{5}{10}\%$ of the total cost of the work; 12% of this cost is labor. Stress is laid on the desirability of designing forms in the drafting room. Attention was called to the tendency of shoring lumber to crush across the grain. A 4-in. x 4-in. post under a 4-in. wide girt is good for 6,400 lbs. Emphasis was placed on the necessity of detailed knowledge of conditions before designing forms or ordering lumber. The points specially mentioned are: story heights, which should be uniform where possible to avoid cutting and splicing of shores. Construction joints should be located by requirements of design and the daily capacity of the concrete plant. The kind of windows should be known in advance and provision made for them.

Mr. Sherwin calls attention to the importance of column yokes and criticizes certain published tables and the recommendations of some clamp manufacturers. He believes that both writers and manufacturers make their requirements much too low. He believes, too, that steel forms, while economical for certain classes of work, are of doubtful economy on buildings, except for columns and column heads, but calls attention to the smooth surface produced by them which can be cheaply finished. Mr. Sherwin's paper will be presented more in detail in an early issue of CONCRETE.

A PROPER USE OF GRAVITY CONCRETE CHUTE

The use of concrete chutes was the subject of a paper by W. H. Insley and C. C. Brown.[33] The great interest in this subject at this time makes it advisable to present this paper in more detail in an early issue of CONCRETE. It was pointed out that properly mixed concrete at the right consistency for maximum strength will flow better than concrete with an excess of water.

CONCRETE VIADUCTS AND BRIDGES OF CINCINNATI

Frank L. Raschig[34] presented a paper illustrated by a large number of lantern slides on "Concrete Viaducts and Bridges of Cincinnati," showing the extent to which the concrete bridge is being developed in Cincinnati.

CONSTRUCTION METHODS ON THE TUNKHANNOCK AND MARTIN'S CREEK VIADUCTS

This paper, printed in advance of the convention, was read by title only, the author, C. W. Simpson[35], not being present. The year of 1915 has recorded the completion of a record number of important bridge structures. Mr. Simpson's paper describes the methods and plant used at the Tunkhannock viaduct. Notable features of this work are the use of a 300-ft. intermediate cableway tower, so designed as to allow the arched ribs of the bridge to pass through it. Steel centering of economical design was reused several times while the use of unit forms for pier construction resulted in great economy of form materials and labor. The importance of careful mixing is indicated by the concrete specifications requiring all concrete to be turned in the mixer for from 2 min. to 2½ min. and limiting the mixer output to 17 batches per hr.

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[31] Chf. Engr., American Can Co., N. Y.

[32] Res. Engr., Aberthaw Const. Co., New Haven, Conn.

[33] Indianapolis, Ind.

[34] Prin. Asst. Engr., Div. of Structures, Dept. of Public Service, Cincinnati

TESTS ON LARGE REINFORCED CONCRETE SLABS

An illustrated paper, "Tests of Large Reinforced Concrete Slabs," by A. T. Goldbeck[36] and Earl B. Smith[37], was presented by Mr. Smith. Tests on slabs having width equal to twice the span length indicated among other things, that the spreading out of the load through the slab varies as the thickness of the slab.

REINFORCED CONCRETE CHIMNEYS

The report of the committee on Reinforced Concrete Chimneys was not complete but observations so far taken indicate that considerable study will be necessary before all problems of concrete chimney design are successfully solved, due largely to the continued heat and extreme dryness which tend to lower the strength of the concrete.

REPORT OF COMMITTEE ON CONCRETE ROADS AND PAVEMENTS

The meeting of the Institute on the evening of Feb. 16 was devoted almost entirely to roads. A feature of special interest and not a little humor was the presentation of changes in the specifications of the Institute for the construction of concrete roads, streets and alleys. The report was made by A. N. Johnson, Chairman of the Institute's committee on Roads and Paving. The principal alteration in the standard specifications of the Institute was with relation to reinforcing, Mr. Johnson reporting that after a serious conference by members of the committee with engineering professors of several universities, the committee was obliged to report that it knew very little about reinforcing concrete paving, that it did not seem to be well understood where the reinforcing should be placed, in what quantity it should be used and that there seems to be no general agreement as to the precise purpose of reinforcing in the design of the road; whether it should be placed at the bottom or at the top or in both places, the committee could not state.

For this reason, Article 5 of the various specifications omits the second sentence which reads: "All reinforcement shall develop an ultimate tensile strength of not less than 17,000 lbs. per sq. in. and bend 180° around one diameter and straighten without fracture."

Article 5, under the main head of "Materials for Paving," now reads, "All reinforcement shall be free from excessive rust, paint or coatings of any character that will tend to destroy the bond."

In Article 30, which describes the use of reinforcing, the committee eliminated the second sentence, which reads, "The cross-sectional area of the reinforcing metal running parallel to the center line of the pavement shall amount to at least 0.038 sq. in. per ft. and the cross-sectional area of reinforcing metal which is perpendicular to the center line of the pavement, shall amount to at least 0.049 sq. in. per ft. The entire specification as to reinforcing now reads as follows:

> Concrete pavement 20′ or more in width shall be reinforced. The reinforced portion shall have a weight not less than 28 lbs. per 100 sq. ft. The ratio of the effective areas of reinforcing members at right angles to each other may vary from 1:4 to 1:1. The spacing in parallel lines of reinforcing members shall not be more than 8″. A reduction of 3 lbs. from the weight specified shall be allowed for those types of reinforcing not requiring extra metal at intersection.
>
> Reinforcing metals shall not be less than 2″ from the finished surface of the pavement and otherwise shall be placed as shown on the drawings attached hereto. The reinforcing metal shall extend to within 2″ of all joints but shall not cross them. Adjacent widths of fabric will be lapped not less than 4″ when the lap is made perpendicular to the center line of the pavement and not less than 1′ when the lap is made parallel to the center line of the pavement.

The committee added the following note on the subject of reinforcing:

> The committee is of the opinion that the weight of reinforcements for streets over 25′ wide shall be greater than 28 lbs. per 100 sq. ft.

In making the report with relation to reinforcing Mr. Johnson said that the committee had thought best, in view of an acknowledged uncertainty, to draw the specifications in a way to admit practically anything offered commercially for road reinforcement now on the market—everything, Mr. Johnson said, "from a railway tie to a bedspring." He thought it would then be up to the advocates of various methods and systems of reinforcing to demonstrate the advantages of various types and quantities.

The committee makes an addition to the specifications in relation to the placing of concrete on reinforcing with the addition of the following paragraph:

> The concrete above the reinforcement shall be placed immediately after mixing and in no case shall more than 45 min. elapse between the time that the concrete below the reinforcement has been mixed and the concrete above the reinforcement is placed.

Further, the committee made a slight change in the specifications for fine aggregate in the requirement that fine aggregate shall not contain vegetable or other deleterious matter nor more than 3% by *weight* of clay or loam. The former specification said 3% by *volume* of clay or loam. Further change was made in this requirement for fine aggregate in the provision for field tests as follows:

> Routine field tests shall be made on fine aggregate delivered. If there is more than 5% of clay or loam by volume in 1 hour's settlement after shaking in an excess of water, the material represented by the sample shall be held pending laboratory tests.

CONCRETE FOUNDATIONS FOR PAVEMENTS FOR HEAVY TRAVEL

A paper on "Concrete Foundations for Asphalt Pavements and Roads Subject to Heavy Travel," by Clifford Richardson,[38] in the author's absence, was presented by title. It called attention to the fact that in this country it rarely happens that the concrete base for heavy traffic pavement is made more than 6″ thick, while in London, England, on one of the streets of heaviest traffic it has been proposed to place 11″ of concrete as being the thickness necessary for the conditions to be met there. Mr. Richardson believes that the enormous disturbance which is continually going on for underground operation and with the increasing weight of the motor trucks, it will be absolutely necessary in this country to build heavier concrete bases for our heavy traffic on city streets.

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[35] Res. Engr., Lackawanna R. R., Columbia, N. J.

[36] Engr. of Tests, Office of Public Roads, Washington, D. C.

[37] Assoc. Mech. Engr., Office of Public Roads, Washington, D. C.

[38] Consult. Engr., Woolworth Bldg., N. Y. C.

THE CONSTRUCTION OF THE EASTON—ALLENTOWN CONCRETE ROAD

John T. Gephart, Jr.'s,[39] paper on "The Construction of the Easton-Allentown Concrete Road," was read in part by Lewis R. Ferguson. Features of this work are covered in considerable detail in an article published in this magazine[40].

CONSTRUCTION OF THE TORONTO-HAMILTON HIGHWAY BY DAY LABOR

H. S. Van Scoyoc[41] presented an interesting paper, illustrated with lantern slides, showing construction work on the 36-mile concrete road being built between Toronto and Hamilton, Ont. He considered the work under the title, "The Construction of the Toronto-Hamilton Highway by Day Labor" and paid particular attention to the organization of the work, the men employed, and the equipment used in handling materials and the use of cranes for loading V-shape dump cars operated by locomotive as a part of an industrial railway system which delivered the material to the work from three different yards. An interesting feature of his description of the placing of materials is in the fact that stone and sand were in two long piles on the sub-grade. After the first stone was dumped the tracks were lifted and placed on top of the stone and further material hauled on this elevation. Numerous details in connection with the construction of this road were presented through the courtesy of Mr. Van Scoyoc in the Feb., 1916, issue of this magazine[42].

THE CONSTRUCTION OF THE DUPONT BOULEVARD, ETC.

A paper by Charles Upham[43], under the title, "The Construction of the DuPont Concrete Boulevard," was read in part by S. Frank Butler[44]. Inasmuch as the DuPont Road is over a private right of way and for long stretches is built on virgin soil, there are some interesting problems in connection with the preparation of the sub-grade, and as the country is flat, special attention had to be paid to drainage. Generally speaking, the soil along the road is sand or clay or a mixture of these, but in some instances the road traverses swamps or depressions where the surface consists of a black muck which becomes very hard in dry weather but very soft and slimy in wet weather. This soil was capable of absorbing and retaining a large quantity of water. Much of this soil had to be removed and replaced with more suitable sub-grade material. In general the swamps were drained and the stumps removed before the fill was deposited. In some instances, however, if this had been done the cost would have been excessive, so the fill was made directly on the surface of the swamp which was floating on about 5′ of black muck underlaid with a solid foundation of sand and bog ore. It was thought that the weight of the fill, which was approximately 5′, would be sufficient to settle it to a firm foundation. This was found not to be the case, however, until holes were cut through the surface of the swamp near the toe of the fill to allow the weight of the fill to force the muck up through the holes. This allowed the fill to settle to a firm foundation. This method resulted in the saving of approximately $1,500 in the preparation of the sub-grade.

The road surface on the section of the Boulevard now under construction consists of 1 mi. of waterbound macadam, 1 mi. of bituminous macadam, and 18.4 mi. of plain and reinforced concrete. The concrete is 14′ wide, 7″ deep in the center and 5″ at the sides on a flat sub-grade. The proportions of the concrete in general are 1 part cement, 2 parts sand and 4 parts stone. Hydrated lime was used in various quantities. Each batch of concrete was mixed for 90 sec. No standard length of slab was adopted, as it was decided that in order to learn what the maximum length of slab should be, joints should be placed only when the concrete mixer stopped for more than 15 min. This resulted in some very long slabs, the longest being 460′. Transverse cracks have appeared in the longest slab and because these cracks appeared at regular intervals and knowing the sub-grade, materials, and construction to be especially good it would seem that practically all of these cracks were due to contraction and followed a regular principle. Steel plates were used at each joint made. Most of the pavement is reinforced, the reinforcing being placed 2″ from the top surface. Before the road is completed it is proposed to use practically all kinds of road reinforcing.

Great stress has been put upon obtaining good material and carrying out proper methods. It is probable that the construction of the highway will result not only in a good piece of road building but in the development of a large amount of information with relation to reinforcing, placing of joints and the use of hydrated lime. So far the use of hydrated lime has been in small quantities only and the information developed is meager.

SPECIAL FEATURES IN PAVEMENT

R. C. Stubbs[45] presented a brief paper on "Some Features in Pavements," in which he directed attention to the possibility of keeping moisture out from under the pavement by means of a deep curb. The fact that the earth beneath the pavement absorbs moisture from the sides in the wet season and gives it off in a dry season results in the edges of the pavement being alternately lifted and lowered in such a way as to induce cracks longitudinally. By building a deep curb instead of a curb and gutter combination, he says he keeps this moisture out from under the pavement by going deep enough to get away from the moisture of the soil at the edges of the road.

CONCRETE AGGREGATES

The Thursday morning session was devoted principally to a discussion of aggregates. In addition to the report of the committee on Concrete Aggregates, notable papers were presented by C. C. Brown[46], "How Shall a Rational Specification for Gravel Concrete be Developed," and by Prof. Duff A. Abrams[47] on tests of 885 sands in connection with the use of gravels for concrete. It is pointed out that many specifications exclude good material as well as pass material that is unsuitable. The great variation of gravel deposits is the greatest obstacle to inspection. The present line of division between sizes of sand and gravel may not be so drawn as to secure best results.

The attention is called to the desirability of having surveys made which will indicate in as much detail as possible the physical characteristics of important gravel deposits. It was suggested that an abrasion test be made a part of the investigation, especially where aggregates are to be used for concrete roads.

The paper by Mr. Abrams on tests of 885 sands is a summarized account of a long series of tests at Lewis Institute. In view of the extended treatment of the subject of concrete aggregates for this magazine[47], on which Professor Abrams is now engaged, detailed report of this paper is believed to be unnecessary.

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[39] Road Engr., Fayette Co., Pa.

[40] Feb., 1916, issue, p. 51

[41] Chf. Engr., Toronto-Hamilton Highway Commission, Toronto, Ont.

[42] P. 54, Feb., 1916

[43] Chf. Engr., Coleman DuPont Road, Georgetown, Del.

[44] Road Engr. for the Portland Cement Assn.

[45] Pres., R. C. Stubbs Co., Dallas, Tex.

[46] Editor, *Municipal Engineering*, Indianapolis, Ind.

[47] Prof. in Chg., Structural Materials Laboratory, Lewis Institute, Chicago

[47] "Concrete Aggregates," by William M. Kinney and Duff A. Abrams, begun in Oct., 1915, issue; second article Feb., 1916; third article Apr., 1916

THE USE OF THE UNIVERSAL SAND-TESTER

The session was closed by a discussion by Cloyd M. Chapman[48], who demonstrated the Universal Sand Tester[49] and explained its use in checking up deliveries of sand as to their proper grading. This instrument, he said, is not adapted to determining the value of any given sample of sand for concrete work, but it does enable the user to perform rapid tests which will determine whether or not a certain delivery of sand approximates a predetermined grading. A simple form of record sheet forms a part of this equipment, enabling the results to be plotted and filed for reference.

REINFORCED CONCRETE IN SEWER DESIGN

"Reinforced Concrete in Sewer Design" was the subject of a paper by W. W. Horner[50]. Mr. Horner points out that beginning with the adaptation of masonry sewer design to concrete by sewer engineers on one hand and radical designs involving very light heavily reinforced designs by concrete experts on the other, the past 10 years have served to modify both types to the needs of sewer construction. He believes that under average conditions a close approach to the circle is likely to be most economical, with variations to suit local conditions. After a discussion of various conditions and construction difficulties which effect the design he makes the following recommendations to sewer designers:

1. Use the best grade of concrete and considerable excess of mortar.

2. Do not work concrete at more than 450 lbs. unless the construction conditions are to be exceptionally favorable.

3. The concrete cover outside of the steel should be at least 2".

4. Use a minimum thickness of concrete of about 9" unless the work is close to the surface, or is to be built under very favorable conditions, and increase this minimum and also the cover over the steel if the conditions are likely to be very unfavorable.

5. Specify the setting of the reinforcement with especially designed holders. These might be made of cast iron and left in the concrete.

6. If there is any possibility that the trench will be very wet or mucky, provide for a sub-base of concrete and provide means of keeping the trench work away from the work, if possible.

7. To secure a concrete that will flow into place with the least resistance, a specification for a 2½-sand or a 3-sand mix should be seriously considered, as might also the use of hydrated lime. This would naturally result also in a denser and more waterproof concrete and might be a very considerable factor in prolonging the life of the reinforcement.

8. Provide for a lining of vitrified brick for the invert, or at least provide an excess internal area to allow for such a lining at some later date. This is of more importance in maintenance than in construction, as under average conditions it is easier to obtain a reasonably smooth invert with the brick than to attempt to finish the concrete itself.

9. Specify cold weather methods. Concrete can be placed satisfactorily and economically at even a zero temperature, if proper precautions are taken. It should be noted, however, that it is quite easy to over-heat the finished concrete and to drive out a portion of the water.

Reference was made to pressure to be assumed which, according to Mr. Horner, may vary greatly, but he suggests that on city streets under a 10-ft. cover a 15-ton roller loading equals 200 lbs. per sq. ft.

Construction details were given attention, including the necessary precautions for cold weather work.

THE FALL RIVER CONCRETE CONDUITS

A paper on "The Design of the Proposed Conduits at Fall River, Mass." was read by Frederick H. Fay[51]. This paper was illustrated by stereopticon and describes the conditions in Fall River, which have led to the designing of a unique series of concrete conduits. These conduits will take the flow from a lake which supplies water, by means of a small stream at the present time, to various mills, the water being used for condensation purposes. Owing to the lack of means of control the present supply is entirely inadequate at some seasons of the year, it is contaminated by sewage and factory waste and has become a nuisance.

A new supply will be arranged from three superimposed conduits. The lower conduit will carry cold water to supply the mills and will be so arranged as to allow an adequate supply at all times. The middle conduit will provide for disposal of surface water and flood conditions, while the upper conduit will take the hot water from the condensers of the mills and by a slight reversed grade return it to the lake which is the water supply, the hot water running in the opposite direction from the water in the two lower channels. It is expected that this unique solution of a hard problem will be carried out in the near future and be of great value to the city both in service and by the removal of unsanitary conditions and through the reclamation of a large quantity of valuable land now unavailable.

THE DURABILITY OF CONCRETE PIPE

In a paper on "The Durability of Concrete Pipe," J. H. Libberton[52] reviewed briefly the progress of concrete pipe and showed the necessity of keeping this product up to its best standard and the ability of concrete pipe successfully to withstand the demands made upon it by sewage and drainage conditions.

CONCRETE CONSTRUCTION AT THE KENSICO DAM

A paper by Wilson Fitch Smith[53] on "Concrete Construction at the Kensico Dam," printed in advance, was read by title only, and the next paper, "The Reconstruction of the Austin Dam," by Lamar Lyndon[54] and Frank M. Taylor[55] was not read. It is expected that this paper will be printed and distributed at a later date, as it is of a rather technical nature and not well adapted to rapid presentation.

MIDDLEBORO WATER TOWER

The construction of the Middleboro, Mass., water tower, an account of which has already appeared in several technical journals, was presented by George Sampson[56]. This paper was illustrated by lantern slides and described in an interesting way the design and construction features of a concrete standpipe, 172′ high, with a hemispherical suspended bottom and having a capacity of 500,000 gals. It is stated that the concrete structure cost only $2,000 more than would a similar steel structure, which is more than offset by the more attractive appearance and the lower upkeep of the concrete structure.

Steel forms[57] were used for the outside of the tank at a cost of $600, while wood forms were used on the inside and cost $400. The greater expense of the steel forms is believed justified on account of the very dense surface obtained and the low cost of finishing. It is stated that while some slight leakage occurred at the bottom of the tank, around the supply pipe, this trouble has been remedied and the tank promises to give entire satisfaction as to its waterproof qualities.

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[48] Engr. of Tests, Westinghouse, Church, Kerr & Co., N. Y. C.

[49] Concrete Appliances Co., N. Y. C.

[50] Engr. in Chg. of Design of Sewers, St. Louis; see article on Concrete Sewer Design by Mr. Horner, CONCRETE, p. 139, Oct., 1914

[51] Consult. Engr., Boston

[52] Div. Engr., Information Bur., Universal Portland Cement Co., Chicago

[53] Div. Engr., Board of Water Supply, Valhalla, N. Y.

[54] Consult. Engr., N. Y. C.

[55] Const. Engr., Austin, Tex.

[56] Consult. Engr., Boston

[57] Blaw Steel Const. Co., Pittsburgh

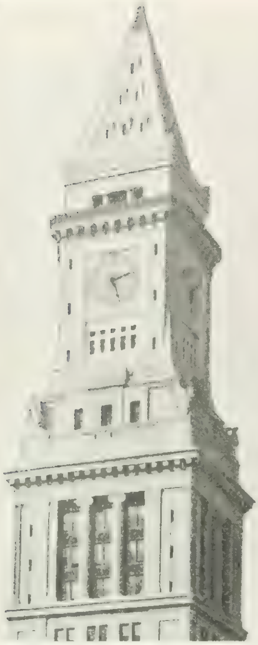

Fig. 1—Top of Custom House Tower, Boston

Concrete Clock Dials—Boston Custom House

By W. B. Conant

The Custom House tower, in Boston, Mass., is provided with a four-face clock, which is about 400′ above street level, the height of the tower being 491′.

Each of the dials is of reinforced concrete, with numerals glazed on the outside, and is 21′ 6″ in diam. and 8″ thick. The figures are Arabic, about 3′ high, all standing vertically.

Bronze castings of the figures, about $\frac{1}{4}$″ thick, 8″ deep and 3′ high, and also 60 minute dots, or round openings, of cast bronze 8″ in diam. and 8″ deep, were first prepared for each of the four dials. Minute dots are set 7″ from center to edge of that dial.

A flat form of matched spruce boards, circular in shape and the size of the dial, was constructed on the floor of the clock chamber. The bronze castings of the figures and the minute dots were secured in proper position to the inner surface of the form by nailing through a thin lip at the outer edge of the castings, and by cleats. A 12-pointed star-shaped bronze plate $\frac{3}{16}$″ thick with points about 5′ long pointing to the hour numerals, and cast in one piece with the axle-box for the hands, was secured, face down, to the form which was then erected within the circle of carved white Vermont marble which outlines each dial.

REINFORCING STEEL

The inner form was built up as the concrete was poured. Two parallel lines of $\frac{5}{16}$-in. round steel reinforcing rods were placed in position, making a complete double network about 6″ apart, within the whole area of the dials. The individual rods were spaced about 4″ apart and the ends of some of them bent to encircle the figures and the minute dot castings.

To add strength to the dials, and to provide a means for securing them at four places, at about equal distances within the circumference, to the inner walls of the illuminating chambers, two 3-in. x 3-in. angle irons were placed horizontally across each dial core 4′ 6″ apart, and two 3-in. x 3-in. angles were erected vertically 4′ apart, and secured to one another by bolts and gussets at their intersections. These angle irons extend to within 15″ of the outer circumference of the dial. The structural steel is secured to the inner wall of the lighting chamber by four brackets, two to each horizontal angle, one end of the bracket being bolted to the angle, the other end to a 24-in. x 6½-in. I-beam forming a part of the steel structure of the wall.

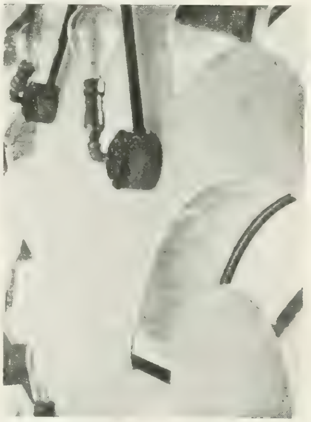

Fig. 2—Inside of Concrete Clock Dial

Note bronze lining to figures and lighting arrangement

The reinforcing rods were wired to this angle-iron structure and the forms filled with concrete from the inside of the tower, making the dials 8″ thick.

After the forms were removed, the figures were glazed in sections numbering from two to five for each figure, and glass fronts for the minute dots were inserted, from the lighting chamber.

The hands for the clock are of wood sheathed with copper, and are electrically operated from the clock chamber. The minute hands are 9′ 6″ long and the hour hand 7′ long. They are designed for incandescent electric lamps to be installed on their front surfaces to illuminate them at night. The illumination of the hour numerals, and of the minute dots is provided for by the flood lighting of the chamber 2′ deep behind each dial, in which 70 150-candle power tungsten lamps are installed, the whole interior surface being painted white to reflect the light, conforming with the exterior of the dials, and 2′ wide. The lights are installed on the back of the dial, in positions so as not to be seen directly through the openings of the figures.

The constructing engineers were the Norcross Bros. Co., and the architects were Peabody & Stearns, both of Boston.

The Science Committee of the Franklin Institute of Philadelphia has made a recommendation, which has been accepted, to award the John Scott Legacy Medal and Premium to Carl E. Akeley, Chicago, for the Cement-Gun.

Out at Long Beach, Cal., there is a great discussion on in reference to the use of concrete for the construction of a reinforced concrete pier at the water-front of that city. Strange to say, in the face of all the knowledge of the availability of concrete under the circumstances named as shown by experience all over the world, one of the opponents of the improvement in a long communication makes the remarkable query: "With all due respect to the promoters of the proposition, I ask them to point out a single instance where reinforced concrete has proved a success as a barrier to the dynamic force of the ocean wave for any great length of time." It is more than likely that the gentleman who wrote that communication will find his mail rather large for some time to come if all those who are familiar with the successful use of concrete under the conditions named take him at his word and reply to his communication.

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[1] Concord, Mass.

Good Results from Unusual Concrete Paving Methods in Sioux City, Ia.[1]

By T. H. Johnson

Two of the most interesting discussions at the Conference on Concrete Road Building in Chicago were by T. H. Johnson, City Engr., Sioux City, Ia. Their interest lies in the fact that Sioux City is, according to Mr. Johnson's statements, getting unusually good results from methods which are admittedly unorthodox. The discussions are based on the reports of two committees: No. 3, on Problems of Design, Thickness, Crown and Grade, and No. 12, on Finishing and Curing. The two discussions are best considered together and are here presented practically in full.

Sioux City has now in use approximately 1,000,000 sq. yds. of concrete pavement, some of it 5 yrs. old, all of it laid under most trying climatic conditions, in widths ranging from 24′ to 52′, on all kinds of soil, with no particular attention paid to drainage, on grades up to 16%, with a leaner mixture than any authority recommends, laid in one course 6″ thick, without a pound of reinforcing steel or a single metal protected joint, and yet we have continuous miles of this pavement without a *single cracked section* and with joints as sound as a dollar. In other words, at Sioux City we are laying practically a crackless pavement, and one that remains crackless under average conditions prevailing throughout the country.

This committee (Problems of Design, Thickness, Crown and Grade) says that the thickness of a concrete pavement depends on nine things, and just what it means when it says that, is that there are nine things that cause a concrete pavement to crack unless it is made thick enough to prevent. Now I believe that our experience at Sioux City indicates that this list includes some things that it should not, and further that there is a better way to prevent cracking than by increasing the thickness.

The climate at Sioux City is very trying upon the pavement slab. The range of temperature is from 115° F. above (in the sun) to 35° F. below zero. During the heat of summer we have frequent heavy rains and very sudden extreme variations in temperature. Take last July, for instance, we had 7½″ of rainfall, three storms averaging 1½″ of rainfall, with a maximum difference in temperatures of 42°. In January, just past, we had a precipitation of 1¾″ only and a range of temperature from 44° F. above to 28° F. below zero. If climate affects pavements, ours should be shot full of holes.

As to width of slab affecting thickness, we have one block of pavement 52′ wide. It is on a street intersecting a viaduct approach and is on a fill of 4′ 6″ at one end of the block and 18′ at the other. The longitudinal grade is about 5½% and at one end there is a transverse grade of 5½%, so that the surface is very badly warped. Immediately before laying the pavement a fill of about 3′ was made at the lower corner of the block running to nothing at the opposite, high side, and about 100′ along the side from the low corner. This fill was made in one layer, and over the heaviest part, two or three sections have cracked. The balance of the block is free from cracks. This pavement is only 5″ thick; part was laid with gravel concrete and part with broken stone. The proportions were 1:3:5. It is 4 yrs. old. This street is subject to much heavy traffic. It is one of the approaches to the Illinois Central freight depot, and on it are located the International Harvester Co.'s warehouse, and a six-story cracker and candy factory. Under such extraordinarily aggravated conditions, with the exceptionally lean mixture, and thin slab, if the thickness were to be fixed by the width, this block should be a veritable checker board of cracks.

We have another street 36′ wide, and more than ¾ mi. long, without a single cracked section. This pavement is 6″ thick and proportioned 1:2½:4.

With reference to the character of the soil on which the pavement is laid; we have a couple of miles laid on a low flat creek bottom, about 15′ above the water in the creek. The district is poorly provided with storm sewers, and the soil is a very heavy, black, retentive soil, almost a gumbo. We have taken no account whatever of sub-drainage. None of this pavement has cracked. The grades on many of these blocks are not over 1%.

Now with the permission of the committee I would like to re-write the list of things that affect the cracking of concrete pavements, and to put them in the order of their importance, as in my judgment, as follows: workmanship, materials and proportions, sub-grade, and traffic. The first two of these, workmanship, and materials and proportions, might be replaced with the one word, *density*. In that one word of seven letters is the solution of the concrete pavement problem—density of the foundation and density of the pavement slab. Density and structural uniformity differentiate the Sioux City pavement.

On grades up to 4% or 5% we lay our highway pavement on a flat subgrade, making the slab 8″ thick at the center and 6″ at the sides. When the grade exceeds the 5% limit we reverse the crown, dishing the slab, making it 7″ thick the full width. We then crown our 8-ft earth shoulders, throwing half the drainage into the side ditch and the other half into the center of the pavement. Our soil washes very badly and we hope in this way to prevent gulleys from forming at the edges of the pavement. Transverse joints are spaced 35′ apart on these roadways. And I want to assure you that we have reason to believe that we can show these roadways a year or two years from now without a single cracked section in the six miles, barring accidents.

The crown of a city street with curbs is another proposition. A crown of 1/50 to 1/70 of the width is more pleasing to the eye than a flat surface, and it also helps very materially in keeping the street clean, as the wind blows most of the litter into the gutters.

As to grades—we have to take them as we find them and where paving is at all feasible, it can be done with concrete. If on account of the steepness of the grade there is a question as to the materials to be used, pave with concrete. It is the least slippery of any we have in use. We have 5½ mi. on grades from 6% to 9% and 2 mi. from 9% to 12% and ¼ mi. from 12% to 15% and ¼ mi. 16%. Even these steeper grades are not corrugated. These pavements are all in daily use and all kinds of traffic seek the concrete streets in slippery times.

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[1] From discussions at National Conference on Concrete Road Building, Chicago, Feb., 1916

[2] City Engr., Sioux City, Ia.

The grade of a concrete pavement depends no more upon climate or the character of the traffic than the grade of any other kind of pavement. Frost and ice make any kind of pavement, even dirt roads, slippery. Concrete is smooth, and offers slight tractive resistance, but it is not "slick." Under wear it retains its characteristic "sandpaper" finish, giving a firm foot-hold to all kinds of traffic.

FINISHING AND CURING

Given proper materials to begin with, the operations covered by the report of this committee (Finishing and Curing) include that which is most vital to successful paving operations, and yet in actual practice, whether through ignorance or indifference, their importance is greatly undervalued and their functions practically ignored. There is a deadly paralled existing between *Finishing* in common parlance and practice, and "the mantle of charity"—both cover a multitude of sins. When these operations come into their own, and their importance is appreciated and their functions are fully understood, and their processes correctly developed, the foundation will have been laid for successful concrete pavements everywhere. Too much stress cannot be laid upon *Finishing*. Upon it, more than any other one thing, unless it may possibly be the quality of materials, depends the quality of the pavement. Every man with a practical working experience with concrete realizes the importance of a liberal mixture of "elbow grease" with the other materials. If I had the privilege of improving the quality of my concrete by the addition of 10 cts. per sq. yd. to its cost, I would choose to add labor to my mixture rather than cement.

In a series of articles in one of the technical magazines, a few months ago, the theory was advanced, and apparently supported by a set of very careful observations and tests, that not over 20% of the value of the cement is developed in ordinary concrete work, because only that percentage is properly hydrated. The other 80%, it was claimed, lies dormant and inert, like any other impurity. If this is true, it naturally follows that any method that will assist in properly hydrating a larger percentage of the cement, will proportionately increase the value of the concrete. Our practice, as embodied in the Sioux City specifications, contemplates this very thing. We use a wet mixture, and put ⅓ the total labor cost of laying the pavement into finishing. As I attribute the exceptional quality of our pavement largely to the method of finishing, I would like to describe it briefly.

Three men with shovels attend to the dumping and leveling of the concrete. We do not permit the use of steel rakes or hoes in leveling, and when concrete is delivered in carts we prohibit the use of the turn-over carts. Following immediately, and keeping within a few feet of the levelers is a man with a wood float 14″x16″ made of 2-in. oak plank, and having a handle 8′ long made of ¾-in. gas pipe. He goes twice over the entire surface. These floatings depress the pieces of coarse aggregate, and bring a flat face of the upper pieces parallel to the surface of the pavement. Also all inequalities of the surface are removed and a true crown established, the weight of the float being such that considerable portions of the concrete may be pushed or pulled around in the process of leveling. This heavy float compresses the concrete, as is shown by the quantity of water brought to the surface, and increases the density of the slab to the extent of the water removed, and further, reduces to the same extent the future absorptive powers of the slab, which is the real benefit conferred.

Following this we apply a dry mixture of 1 part cement and 1 part fine aggregate, in sufficient quantity to absorb all free water. This dry mixture does a number of very helpful things. For instance, we are told that it takes about 4 cu. ft. of water to mix an ordinarily wet yd. of concrete, only about half of this water being used in hydrating the cement, the other half remaining in the concrete as free water. In other words, 7½% of the total volume is free water, and if left there to evaporate there would result voids equal to 7½% of the mass.

Our first floatings remove a portion of this free water and so close up the structure of the concrete that subsequent evaporation is materially discouraged. The dry mixture completes the removal of this free water, as is shown by the immediate stiffening of the concrete so that the balance of the finishing is done directly from its surface, without disturbing it a particle. It also furnishes enough mortar for properly finishing the surface. Being a rich mixture, it counteracts the effects of dust, dirt and other impurities brought to the surface by the water, and effectually seals all the pores in the pavement, preventing evaporation, and affording a hard, tough, dense, impervious skin coat for the surface of the pavement.

After this dry mixture is applied, it is floated until thoroughly incorporated with the surface of the concrete. Subsequent floatings follow at short intervals as long as any moisture is brought to the surface. When the mortar begins to stick to the floats, and is slightly drawn after them, which is usually at about the seventh floating, the floating is discontinued. This leaves the surface rough, and it quickly sets with a hard, flinty glaze. This roughness of the final floating is frequently perceptible after two years of wear.

That you may appreciate what "floating" means with us, I want to tell you that these floats, made of 2-in. seasoned oak, are worn out and have to be replaced in two days.

Whether it be fact or fancy as to the history of fire losses in the U. S. and the effect of concrete in this connection, a remarkable thing remains beyond contradiction, and that is that the fire losses in the U. S. and Canada for 1915, amounting to $183,000,000, were $50,000,000 less than in the year 1914. This continually reduced rate in fire losses in the U. S. in the last few years may or may not be due to the use of concrete, but when the reduced fire losses and the increased concrete building construction are taken in connection with each other, there may be some reality in the thought that the reduction in fire losses in this country is really due to the increased use of concrete. According to a report of a fire which took place in New York not so long ago, reduced loss of life by fires seems also likely to follow. In a large apartment house on East 78th St. in New York, known as the East River Homes, a fire took place in the basement. The floors above became so hot it was expected the whole building would go. The occupants, however, were not in the least alarmed. They held the fort and refused to move their furniture, even when ordered to by the police, and one woman went on with her work as though nothing had happened. A most unique situation was thus presented and all because the building was of concrete. What would the results have been in an apartment house of the same kind built in the ordinary fire-trap construction?

A System of Home-Made Wall Forms as Worked Out by Two Builders

It has often been found, when the need for equipment to accomplish a certain object has arisen, that two or more men working independently would hit upon the same solution of the problem. This is shown in the development of a number of years experimenting by F. J. Beaty, Chowchilla, Cal., and working independently by August Matzke, Winona, Minn. Each has erected a number of interesting buildings with his system of forms and finds it a very successful method. Fig. 1 shows the construction. Mr. Beaty uses forms made up of 2 in. x 12 in. plank surfaced on both sides and brought to uniform thickness and width. At frequent intervals small pieces of lumber about 1-in. x 2-in., called clips, are nailed to the planks, projecting about 1½″. Mr. Matzke uses shiplap with 2-in. x 2-in. cleats.

The method of erection is as follows: The line of forms is run around the building and wires are twisted around the projecting ends of the clips. Spacers are inserted and the wires twisted tight. A second section is then placed, the ends of the plank sections being brought opposite a clip, as shown in Fig. 1. These two courses of plank forms are filled and the concrete is allowed to set from 6 hrs. to 10 hrs.; the lower forms are then removed by cutting the wires and turning them up so as to support the upper line of plank. The lower planks are then placed above the section on the wall and the work continued. It is stated that enough forms to go around the building twice are usually sufficient to take care of the work. Forms are oiled with crude petroleum before being used, and it is stated that they are in good condition after erecting several buildings.

Woven wire mesh is used as a reinforcement and is placed as shown in Fig. 1.

The window frames are made of 2-in. x 6-in. lumber, placed in the wall as the work progresses, as shown in Fig. 2, and fastened to the concrete by means of nails driven into the back of the frames. No wood sill is used, the sash fitting directly on the concrete sill. The joint is covered by an astragal molding, and the sash secured by beads in the grooves as shown. Pullman spring sash balances[1] take the place of weights, making a distinct saving in cost, due to the extremely low-cost frame.

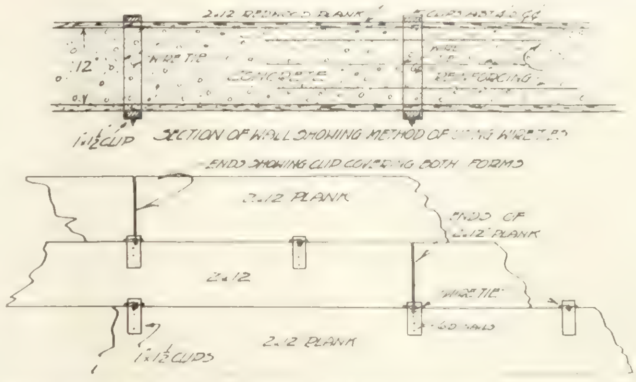

Fig. 1—Detail of Formwork, Showing Clips and Reinforcing

Although Mr. Beaty has erected several buildings, one of the most interesting of his jobs is a small engine room and elevated water tank, shown in Figs. 4 and 5. It was desirable to secure at a reasonable cost a permanent structure and one that would present a good appearance.

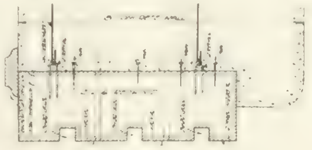

Fig. 2—Window Frame Detail

The footings were made 2′ larger than the size of the water tank so as to secure a stable base, and then 16-ft. boards, tacked together at right angles, were set upright at each corner to form a nailing base and support for staging. Just inside the corner were placed sections of 8-in. concrete tile, and inside the tile 2-in. supply and waste pipes, with the proper connections. Wires were looped around the 2-in. pipe and led out between the joints of the concrete tile to form a bond for the future walls of the engine room. The concrete pipe were placed two at a time and filled with concrete until the bottom of the tank floor was reached. Concrete for filling the columns was mixed 1:6 cement and well graded bank sand and gravel. This formed an inexpensive column 10½″ in diam., reinforced by the water pipe and by the reinforcing which was in the concrete tile, making substantially a hooped column.

To the scaffold frame were fastened 2-in. x 8-in. fir joists extended 3′ beyond the tower, forming an outside scaffolding. On these joists a floor was laid, with round openings over the columns. Forms 4″ high were laid on the floor so as to allow a projection 2″ beyond the walls of the proposed tank to form a belt course. The floor was reinforced with steel wire fencing of No. 12 wire, which was the best reinforcement that could be had locally. The fencing was cut

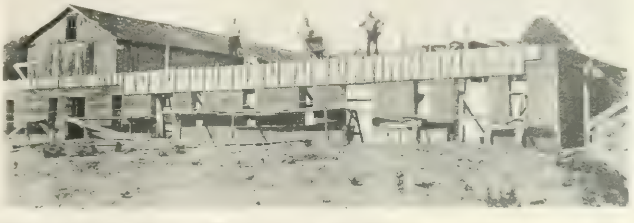

Fig. 3—Forms as Used by Mr. Matzke at His Farm

in lengths long enough to reinforce the floor and turn up the entire height of the tank and then turn again to form a bond with the roof slab. An additional reinforcing to the walls of the tank was provided by winding barbed wire around the forms as the wall was poured, two strands to each foot. The floor was poured of a 1:2:4 mix and is 4″ thick. As soon as the floor had begun to set the form was set for the inside of the tank, consisting of plank on end with a plank in each corner set so as to chamfer the corner 8″ (see Fig. 4.) The 12-in. plank forms were then placed for the outside, as has just been described, and the walls of the tank were poured. By pouring only the height of one plank at a time the reinforcing can be watched carefully and kept in its proper place. The walls of the tank are 4″ thick and Mr. Beaty considers them amply strong for this size of tank, 8′ x 8′ x7′ 6″ which holds 2,100 gals. The inside forms were removed in about 24 hrs., the walls floated and painted with a wash made of cement and water. The roof forms were then placed, providing for the overhang of 4″. Roof slabs are $3\frac{1}{2}$″ thick and reinforced with wire fencing. The roof is provided with a suitable manhole.

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[1] Pullman Mfg. Co., Rochester, N. Y.

An inspection of Fig. 5 will show braces for the tower. These are $1\frac{1}{4}$-in. gas pipe placed in position as the columns were poured and forming an extremely rigid brace. The engine room is constructed of Hy-rib[1] wired to the columns and to horizontal pipes which were placed at the height of the roof. This Hy-rib, plastered on both sides, forms the engine room. As can be seen from the cut, it presents a very pleasing appearance and insures the owner against repairs.

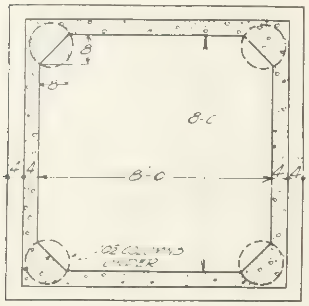


Fig. 4 —Section Through Tank

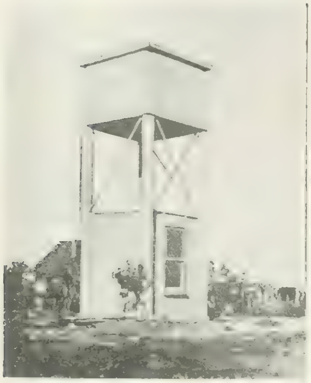


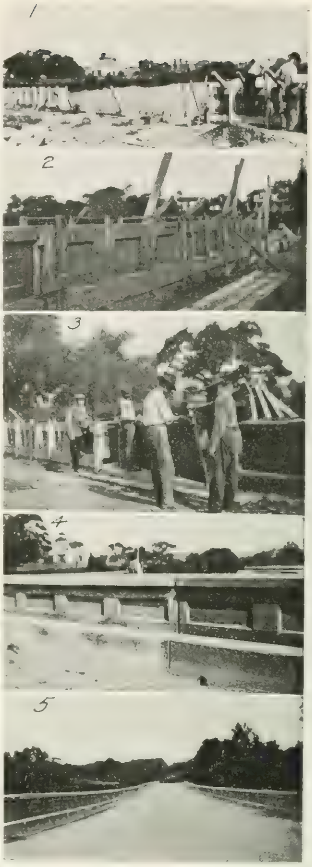
Fig. 5—Reinforced Concrete Water Tank

Building a Bridge Balustrade

Building the concrete balustrade for a bridge at Patchogue, N. Y., by F. Arrigoui & Bro.[1] is illustrated from photographs from Mrs. M. S. Bartow. The series of illustrations makes little explanation necessary. It will be noted that the balustrade was built in sections such as are used to prevent cracking by expansion. Expansion joints were provided as shown at Fig. 4. Concrete was placed in wood forms, the construction of which is shown at Fig. 2. The concrete was mixed of suitably graded aggregate, consisting of $1\frac{1}{2}$-in. crushed trap rock, sand and cement; $1\frac{3}{10}$ bbls. of Saylor's[1] Portland cement was used to the cu. yd.

Fig. 3 shows forms being removed and gives a good idea of the appearance of the concrete before any finishing work was done. Fig. 4 shows finished wall which has been brush-coated with a sand-cement mixture and rubbed as shown. Note the weep hole to drain the roadway.

Fig. 5 gives a good idea of the appearance of the finished structure.



Building Balustrade for a Concrete Bridge

Where under surfaces of slabs are to be plastered, a scattering of coarse sand or fine gravel on the forms will result in a surface insuring a better bond.

The present tendency to shorten the mixing time excessively is being considered with suspicion by many engineers; however efficient the machine, the time cannot be cut to extremes without sacrificing quality.

Carpenters should not be allowed to do sawing over finished forms after reinforcing is placed.

In order to obviate hold-ups in prices for cement, the Highway Commissioners in various California counties are being given authority to build concrete or any other kind of a roadway that they may decide upon. The purpose is to provide by the giving of this option for possible advances in prices of cement or other materials for concrete. California is building roads in such a liberal, broad-minded way, and devoting so much of her money to concrete road construction that her legislators deem it wise to protect their communities against any advance in price by allowing them to select the type of road, and this is especially wise when some of the contracts talked about involve from 75,000 bbls. to 100,000 bbls.

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[1] Trussed Concrete Steel Co., Youngstown, Ohio

[1] Coplay Cement Mfg. Co., N. Y. C.

Unit Costs in Building Construction

By Sanford E. Thompson[1]

This paper is to call attention to the necessity for more accurate estimates by architects, engineers and contractors, and to the possibility of reducing construction costs by a more thorough analysis and systematizing of the labor operations.

Open any technical paper giving construction items and notice the enormous variation in bids received from contractors for the same job. At random I open a current engineering periodical and find the four bids on a certain job: $117,000, $126,000, $143,000 and $171,000. This does not represent an exceptional case, but is the general rule on work in which the cost of labor is relatively large.

Unquestionably the methods of management, especially on construction jobs, affect the cost to a very large extent, but it is hardly conceivable that differences of, say, 50% in cost can be accounted for in this way. Assuming, as is generally the case, that the bidders really try for the job, there is evidently gross error in many cases in the estimating. The variations must be due to one of three causes: (1) inaccurate estimate of volumes or costs of materials; (2) inaccurate estimates of labor costs, or (3) inaccurate estimates of overhead costs and profits. Note that I have combined the items of overhead and profit because they are practically interdependent. The contractor, for example, who handles a job personally has small overhead expenses but requires larger profits to make up for the value of his own time than does a large contractor whose overhead in salaries and plant is large but whose percentage of profit may be small and yet yield a large total income.

Material costs are usually figured without trouble. The variation in overhead by two different estimators may be large because many contractors do not properly charge or divide their overhead items, but this difference on any one job can hardly account for more than 10%. The big variation, then, must be in the estimated labor cost. As a matter of fact, this is the item on which money is made or lost in contracting.

A contractor was asked recently why he did not bid on a certain reinforced concrete bridge. The reply was: "I have built mine." Construction companies handling reinforced concrete will tell you that a contractor does not begin to make money until he gets his third job, provided he stays in the game as long as this. The first job costs him more than his estimate; he bids low on the second job because he thinks he sees where he lost money on the first; on the third job he knows that he has been a fool and adjusts his bid accordingly.

It must be the aim not simply to know how to do the work cheaply but to figure estimates more accurately, at the same time taking care to keep the cost of the figuring as low as possible. It is useless to get a job at a low figure and lose money on it. It is evident, further, that having made the bid with care, the construction must be handled in such a way as to come within the limit set. This requires not simply a fair comparison with the monthly estimates, but the follow-up from day to day of quantities and wages so as to have a running check on the work. It takes but little more time in figuring an estimate where material costs are estimated in detail to go also into unit costs of labor. This, of course, is not simply a mathematical proposition but requires a knowledge, based on first-hand experience, of actual costs, or else on records where conditions are stated in full.

In reinforced concrete construction, the greatest discrepancy lies in the cost of forms. It is here that the contractor and also the engineer is apt to be fooled, unless he is either well provided with unit costs or has previously handled work of an identical nature. Suppose, for example, a builder has been accustomed to building forms for heavy concrete, such as core walls for dams, heavy foundation work, and mass construction. He finds from his records that the cost of labor for such forms, not including overhead and profit, is 50 cts. per cu. yd. He bids on a reinforced concrete building, and adds, say, 50%, or say, 100% to be on the safe side (such a percentage guess as this is by no means uncommon in estimating), and figures $1.00 per cu. yd. for labor on forms. Instead of the $1.00, he may find the cost to be about $4.00 per cu. yd., and discovers further that the cu. yd. basis is absolutely incorrect. He then adopts the sq. ft. as the unit. This is better, but let us see how this may work out.

Suppose that his first job in building construction is a design calling for 250 lbs. per sq. ft. of working load, with long spans, columns averaging 24″ square, and beams and girders of similarly large size. The new job, we will say, has a load of 125 lbs. per sq. ft., with columns averaging 15″ and correspondingly smaller beams and girders. He realizes that he must not use the cu. yd. unit for figuring his forms. If he did this, he would find when he got through that the cost per cu. yd. of his labor on the smaller size members was nearly double that on the other job. He uses then the sq. ft. basis. On the building with heavy load, the labor cost of the column forms, using columns only, to be specific, was, we will say, 8.3 cts. per sq. ft. We will suppose he uses this on the building with light loads. The estimate will be absolutely incorrect. It costs only a little less to make and to erect the smaller forms than the larger, although, on the other hand, enough less to throw the scale in the other direction if the cost is assumed equal, member for member. On the light load building, as a matter of fact, the labor cost on the 15-in. columns is about 1/4 greater per sq. ft. than the cost on the building with columns averaging 24″ x 24″, while the cost per member is 16% less. Costs, based on accurate unit averages, checked by work on various jobs, show the following comparison of 15-in. and 24-in. column costs, each in a building of 12′ total story height, and all other conditions the same.[2]

Size of Col.	Cost per Cu. Yd.	Cost per Sq. Ft.	Cost per Member
24″	$4.50	$0.083	$8.00
15″	9.68	0.105	6.74
% Increase	115%	27%	16%[3]

You may say that this is an extreme case, but I am quoting almost exactly from an actual case of a contractor of large experience in building construction but with limited experience in reinforced concrete construction, who used, not the sq. ft. method, but the cu. yd. method of estimating in two buildings with heavy and light load. Fortunately for him, he built the heavy building first, and so simply lost the job on the second building by figuring 'way up in the air.

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[1] Consult. Engr., Boston (Paper presented at the Am. Concrete Institute)

[2] From *Concrete Costs*, by Taylor and Thompson, 1st Edition, p. 631

[3] Decrease

Much has been written of the inaccuracy of "cost data" and with perfect truth. On the other hand, if the unit costs are taken from personal experience or from records in which all the local conditions are fully stated and average values compiled, they are of immense value in estimating and in following up the work. Care must be taken, of course, to provide for indirect charges, such as foreman, sharpening tools, time on miscellaneous work, plant erection and contingencies. In addition to these are the charges for superintendence, contingencies chargeable to labor but not estimated as part of pay roll, odd tools and appliances not carried to next job, liability insurance, etc.

To illustrate the variations in labor costs of different members in form construction, the table below presents a few values selected from "Concrete Costs."[4]

Costs of this kind are useful not merely for contractor's estimate, but perhaps even more for comparing different designs by engineers and architects. Reference might be made, for example, to studies for the new Technology buildings,[5] in which it was found that for three different types of floor design a long-span slab was the cheapest on account of the difference in the cost of form construction.

REDUCTIONS IN CONSTRUCTION COSTS

Up to this point the author has considered the substitution of accuratee methods for guess work in estimating. The more important question is how far the knowledge, such as has been referred to, can be utilized in reducing costs. Accurate cost keeping is of value in following up construction costs from day to day, in showing up waste labor and in providing a mark for the attainment of superintendents and foremen. Unless cost knowledge is in the form of small units, such comparisons cannot be made satisfactory.

To get the full benefit of a knowledge of unit costs, and in fact for this the knowledge must be even more thorough and include the unit times of performing the various operations, it must be utilized in planning the work in advance and in distributing materials and jobs; in selecting materials and methods which will result in lowest labor costs; in adapting the construction plant to the special conditions; and, carried to its ultimate end, in laying out jobs for the workmen and giving them a reward for accomplishment.

Such management as this involves the adoption of factory methods in construction. Already the need of this is being recognized, but to a limited degree only. The president of one of our large and most up-to-date construction companies stated recently that on one job he made a saving of $10,000 by the adoption of methods involving systematic planning and routing.

Limitation of time forbids a more complete discussion of this most important problem. Full economy in construction, however, will only be attained as the builder discards the haphazard rule-of-thumb method and considers his job with a view to thorough analysis, planning functional methods and a complete study of details. By such methods as these will the labor of construction be brought to a more scientific basis and more nearly on a par with the material end of the work.

LABOR COSTS OF FORMS FOR COLUMNS, BEAMS, GIRDERS AND SLABS

Costs include 10% for foreman and 15% for superintendence, contingencies, etc., but do not include profit or home office expense. Carpenter labor, 50 cts. per hr.; ordinary labor, 25 cts. per hr. Material, 1-in. lumber.

12-ft. Columns—Labor Cost for Member Iron Clamps

Size	Make Form	Place and Remove Form 1st Time	Place and Remove Form After 1st Time	Remake, Place and Remove Form
8" x 8"	$1.16	$4.68	$3.77	$5.53
16" x 16"	1.46	5.45	4.40	6.16
24" x 24"	1.80	6.20	5.14	6.86
36" x 36"	2.61	7.64	6.33	8.14
20-ft. Beams—Labor Cost per Member Size Measured Below Slab				
4" x 8"	$0.92	$2.42	$1.97	$2.79
6" x 12"	1.09	2.75	2.31	3.23
8" x 16"	1.26	2.99	2.59	3.64
12" x 24"	1.75	3.41	3.09	4.29
20-ft. Girders—Labor Cost per Member One Intersecting Beam				
8" x 16"	$1.38	$3.27	$2.75	$4.31
12" x 24"	1.82	3.86	3.20	5.02
Labor Cost of Slab Forms[6] per 100 Sq. Ft. of Slab Surface				
	$0.81	$2.53	$1.90	$2.06

For inexperienced builders increase costs 33⅓%.

For special design, add 10% to 50% to "Make Forms."

If no mill saw on job, add 50% to "Make Forms."

If old lumber is used, add 75% to 100% to "Make Forms."

For rectangular columns, select values for square columns having the larger dimension of the rectangle.

For wall columns, add 50% to all except "Make Forms."

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[6] Based on slab built two panels per bay

The strength of concrete is seriously diminished by the addition of a very small percentage of sugar. Mixing water used near factories handling large quantities of sugar should be carefully watched.

Zeppelin Bombs Fail to Wreck Concrete Building

In the presidential address by Henry Adams delivered at the 64th Ordinary meeting of the Concrete Institute of England, some interesting facts in connection with Zeppelins were brought out and the effect of bombs on concrete was referred to. According to investigations made by the government after the Zeppelin raid of Oct. 13, 1915, it appeared that a bomb dropped on a roof of a modern building constructed of reinforced concrete with steel and concrete roof did no damage, while similar bombs practically caused the entire destruction of brick buildings in the same vicinity.

In an official account of the raid the effect of the bombs is described as follows:

REINFORCED CONCRETE BUILDING

The third area contains two damaged business premises, the first of them a large and modern building constructed of reinforced concrete, and with a steel and concrete roof and flooring. Two bombs dropped in this building, one of them actually on the roof, and one on the pavement immediately beneath the doorway. The bomb on the pavement appears to have exploded sideways; at any rate, the damage done, which consisted chiefly of broken glass and plaster, occurred mainly in the houses on the other side of the street. The bomb which dropped on the roof of the building itself did little damage.

ORDINARY BUILDINGS

In the same area a bomb dropped on the roof of a small hotel. In this case the strength of the building, which was an old one, was not sufficient to withstand the force of the explosion, and the whole of the hotel, which consisted of three floors of the building, was entirely blown up.

The second area contains a large block of residential flats. This one has a stretch of garden behind and one of the enemy's high explosive bombs fell in this garden, close to the flats themselves. One or two rooms on the ground floor were totally wrecked, and on the first floor considerable damage was done.

The washing out of the road-beds of railroads is a serious thing in California, where tremendous bodies of water coming down from the mountain carry all before them. A former president of the N. Y. Central R. R. who has just been visiting that part of the world suggests concrete road-beds as a solution of what is becoming a serious problem on the Pacific Coast. He says: "California railroads, in order to cope with situations caused by these annual washouts, must, as the ultimate solution, be built high and dry on concrete beds that will be safe and permanent."

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[4] For complete tables, see *Concrete Costs*, by Taylor and Thompson, 1st Ed., pp. 630 to 654

[5] Boston; see paper by author presented before Am. Concrete Institute, 1915

Convention of the American Concrete Pipe Association

The American Concrete Pipe Assn. held the first session of its annual convention Thursday afternoon, Feb. 17, at the Auditorium Hotel, Chicago. The attendance was large and the interest and enthusiasm manifested promise much for the development of the concrete pipe industry during the coming year.

SHOULD MANUFACTURERS CONTRACT FOR LAYING THEIR OWN PIPE?

The first paper was by C. M. Wood.[1] Mr. Wood takes the ground that while there may be instances when it is advisable that the cement tile manufacturer maintain a contracting organization and lay his own pipe, in general such a course will act against the industry by arousing the antagonism of drainage contractors with whom the concrete tile manufacturers should work in harmony. He believes that the efforts of the tile manufacturers should be devoted to an educational campaign to show the drainage contractor and the engineer, as well as the tax-payer, the advantages of the use of concrete pipe. It is suggested that wherever possible the manufacturer should take the engineer or contractor to his plant, show him in detail the manufacturing process and the precautions taken to insure a perfect product. Mr. Wood calls attention to the desirability of close association of manufacturers in their organization to make it possible for the organization to promote the use of concrete pipe through standardization and co-operative effort.

THE USE OF DRAIN TILE IN ARID REGIONS

The paper by Lewis R. Ferguson,[2] on the use of drain tile in arid regions, reviewed briefly the methods used in the reclamation of land and the conditions which result in depositing alkali salts on the surface of reclaimed land.

He pointed out that land which had been extremely productive was ruined by the appearance of these salts and that drainage has in most cases proved to be an effective remedy. Most of the land in which this condition occurs is remote from supplies of clay tile, whereas concrete materials are usually abundant. Mr. Ferguson said in part:

> A serious question to be considered is, does alkali salt disintegrate concrete? If concrete can be made to withstand the action of alkali the possibility of the use of concrete drain tile throughout this section is enormous. The disintegration of concrete when exposed to concentrated salts in irrigated districts has been a subject of discussion by engineers and users of cement for the last 10 yrs. or 15 yrs. There are many concrete structures in these districts which do not appear to be affected at all, but there are others which show indications of being attacked.
>
> In order to determine what the effect of alkali is on concrete and in order to determine how concrete drain tile can be made so that they will be successful in alkali soils, an investigation was undertaken by the U. S. Bur. of Standards.[3] (This work is outlined by Mr. Ferguson.)
>
> So far, the investigation has proved decidedly encouraging from our standpoint. At the end of two years we found that the alkali waters have not in any degree reduced the strength of the tile expected to stand alkali, and we feel that this is good evidence that such tile will be permanent. To most of the projects clay tile must be shipped long distances and the cost of freight and the loss due to breakage is excessive. The field is a most advantageous one for concrete. The conditions, however, are rigorous and the best quality of product only will prove satisfactory. I believe that with proper care in the selection of the aggregate, proper care in the mixing of the concrete and the manufacture of the tile, and in their curing a quality of product can be produced which will meet the requirements and that ultimately most of this land will be saved by concrete drain tile.

Rudolph J. Wig, of the U. S. Bur. of Standards, gave some further details of the tests now under way.

MY EXPERIENCES IN STARTING A CONCRETE TILE PLANT

H. J. Backemeyer[4] described "My Experiences in Starting a Concrete Tile Plant." He handled the matter mainly from a sales standpoint but gave as his experience that it is generally necessary to begin action at the very inception of a drainage project so as to have the specifications so worded as to admit concrete tile. He points out that it is very difficult to get specifications changed, once they are drawn. He believed that the proper method of securing favorable attention to concrete pipe is to meet each member of the committee or board in charge individually and informally, to take up with him in detail the manufacture of concrete pipe and its advantages. He believes that much more favorable attention can be secured and that the individuals approached will ask questions more freely and be better impressed in this way than by any attempt to present the merits of one's product at a Board meeting. He stated that the methods outlined have been very successful in securing suitable specifications. In regard to convincing the engineer in charge of the desirability of concrete pipe, Mr. Backemeyer believes that the greatest obstacle present is the lack of uniform specification and means of conducting definite tests in small communities, where elaborate testing equipment is not available. He states that efforts are being made to produce a testing machine which is portable and by means of which tile can be tested even along the drainage ditch itself to the complete satisfaction of those responsible.

COMMITTEE ON RESOLUTIONS

A committee on Resolutions was appointed by the Chair, consisting of J. J. Hammen, Spencer, Ia.; P. H. Atwood, Armstrong, Ia., and A. P. Young, Paullina, Ia.

THE ASSOCIATION BANQUET

The Am. Concrete Pipe Assn. held its annual dinner at the Auditorium hotel, Thursday evening, Feb. 17. Former Gov. A. O. Eberhart, of Minnesota, was the principal speaker. Mr. Eberhart laid stress on the benefit of organization to an industry and made a strong plea for good concrete as the basis on which a business ought to be built.

C. M. Wood was toastmaster, and brief addresses were made by a number of those present.

CONCRETE PIPE AND TRAFFIC REGULATIONS

A feature of the session Feb. 18 was a discussion of traffic matters as related to concrete pipe. It was pointed out that under the new Western classification, concrete pipe is required to be very carefully packed in the cars with 2 x 4's across the bottoms to hold the bell ends and that each tier must be crated. It was explained that this requirement is in part the result of the activities of the clay manufacturers whose product requires this kind of packing to avoid breaking, but that concrete pipe, being much stronger, will stand rougher treatment and does not require such expensive packing. It was also pointed out that concrete pipe can be piled higher in the car and that concrete pipe manufacturers should be willing to take a higher minimum loading, which can be done without risk to the product. It was also brought out that the railroad companies should be advised that as concrete pipe weighs more per ft. than the clay product, it is to their advantage to make traffic regulations that will be advantageous to concrete pipe and thus secure a larger tonnage for a given contract.

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[1] Mgr., Concrete Products Bur., Portland Cement Assn., Chicago

[2] Asst. Secy., Portland Cement Assn., Chicago

[3] See CONCRETE, Oct., 1915, p. 145, for details of first year's investigations

[4] Sioux City, Ia.

A Traffic committee was formed consisting of C. M. Wood, Chicago; H. E. Backemeyer, Sioux City, Ia.; and John L. Zeidler, St. Joseph, Mo.

ADVANTAGES OF BIG TILE OVER THE OPEN DITCH

A paper calling attention to the advantages of big concrete tile over the open ditch for drainage projects was presented by G. E. Warren.[5] Mr. Warren pointed out that the open ditch is not a satisfactory drainage device owing to the difficulty in maintaining such a ditch and to the fact that where enough fall is given to the drain to dispose of large quantities of water, erosion is a serious matter. He points out that erosion varies with the square of the velocity, so that the increase in speed of the water is also a serious matter. Big concrete tile, on the other hand, are much more effective under currents of comparatively high velocity and present additional advantages in the fact that no land is wasted and there is no objectionable growth of weeds and no trouble from cattle running in the drain. The speaker pointed out that the maintenance of open ditches is a large item and that in fact they are usually replaced by a closed drain at some later period, so that eventually they are a total loss. Such ditches also tend to cut the land up into irregular shaped plots, which is a disadvantage to the farmer.

The method of organizing drainage commissions for co-operative work was outlined and it was suggested that the tile manufacturer should place himself in a position to advise on drainage problems and keep in touch with projected work in his vicinity.

POSSIBILITIES FOR THE USE OF CONCRETE TILE IN THE MISSISSIPPI VALLEY

C. H. Young[6] presented a paper on "Possibilities for the Use of Concrete Tile in the Mississippi Valley." Along the lines covered by the previous speaker he stated that a 36-in. concrete tile is now an economical size but that much depends upon the grade of the tile as compared with that of the open ditch. According to Elliott's tables, a 24-in. tile laid on a 2/10 % grade will drain about 2,600 acres. To drain the same area would require an open ditch 4′ deep with a grade of 6/10 %, and an average water width of 6′. This would require a top width of 12′. A 36-in. tile having twice the area of a 24-in. tile and twice as great a discharge will drain 6,000 acres. To drain the same area would require a ditch 4′ deep, 16′ wide, with an average water width of 8′. The speaker noted that while the first cost of the ditch is low as compared with tile, a 16-ft. ditch with banks and shoulders destroys an acre of land in 40 rods and requires constant upkeep.

Mr. Young touched upon the business advantages of concrete tile, as all material and labor are obtained from local sources. He cited a number of instances to show that installations of concrete tile pay well, often bringing an annual return of from 33% to 50%, and even 100%. The increase in value of the land drained results in increase in valuation of nearly 100%.

REPORT OF COMMITTEE C-6

The report of Committee C-6 of the Am. Soc. for Test. Mat. was presented by George P. Dieckmann.[7] The proposed specifications suggested a resolution to take out membership in the Am. Soc. for Test. Mat., with a view to securing proper representation in the Society with reference to sewer pipe. The proposed specifications will probably be sent out to the members of the Pipe Association for further discussion and comment.

REORGANIZATION OF THE AMERICAN CONCRETE PIPE ASSOCIATION

The principal change in the constitution and by-laws is the increase of dues from $5.00 to $10. This step was taken in order to allow the Association to do more aggressive work in the cause of concrete pipe. It is believed that the present condition of the industry warrants the higher membership fee. This increase was approved by the Association and in addition a tonnage tax was proposed to secure additional funds. This was not approved, for it was thought that the increased membership fees will provide the funds necessary in the coming year, particularly as the reorganized Portland Cement Assn. will lend its aid through its Cement Products Bureau.

MEETING OBJECTIONS TO CONCRETE TILE

A paper by F. S. Phillips[8] took up some of the reasons why buyers are not using concrete tile. Mr. Phillips condemned the practice of some manufacturers who, he says, occasionally try to account for inferior tile by blaming the materials which they use. He pointed out that to do this immediately weakens the faith of the customer and that not only should a good product only be turned out but that any defective tile or breakages should be disposed of so as to not create an unfavorable impression on the visitor at the plant. He pointed out that stock should be kept up and that the plant should at all times be kept in a neat and workmanlike condition. It is important that the customer secure prompt deliveries, as this often determines the material he will purchase. He suggested that manufacturers arrange to lay tile in the vicinity of their plants and maintain test specimens so that it will be an easy matter to show the customer just what the product will do under time and weather conditions.

REINFORCED CONCRETE PIPE

The subject of reinforcing concrete pipe was discussed by L. M. Stollard.[9] Mr. Stollard discussed the theory of loading pipe on which reinforcing systems are based and described a number of types of reinforcing, with their relative advantages and disadvantages.

ELECTION OF OFFICERS

The following officers were chosen for the ensuing year: Pres., G. F. Lillie, Fremont, Neb.; vice-pres., F. W. Scanling, Crisman, Ill., and treas., E. S. Hanson, Chicago. The directors are: Harry Cain, Mankato, Minn., and W. D. Middleton, Emmettsburgh, Ia.

The success of the president in conducting the affairs of the Mid-West Cement Users Assn., of which he is also president, suggests that the organization is entering upon an exceptionally successful year.

When lapping the ends of reinforcing rods they should not be closely wrapped with wire; the concrete must have free access to all parts of the steel.

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[5] Universal Portland Cement Co., Chicago

[6] City Engr., Muscatine, Ia.

[7] Chf. Chem., Northwestern States Portland Cement Co., Mason City, Ia.

[8] Chicago

[9] Muscatine, Ia.

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Insulating and Waterproofing the Roof of an Underground Room

THE QUESTION BELOW IS DISCUSSED BY:

WILLIAM KINNEY[1]
A. M. WOLF[2]
CARL H. FULLER[3]

"I am going to build an underground room beneath a terrace in connection with my residence. I propose to have the walls of monolithic concrete 1′ thick. I want to put on a flat roof of concrete which will be partially covered with earth, and I want to avoid any possibility of moisture coming through the slab, or sweating on the inside. What is the best way to provide the necessary insulation to avoid the sweating?"

BY MR. KINNEY

Unless this room is to be used for cold storage purposes, it is probable that the method of construction described below will provide all the insulation necessary to avoid sweating.

The roof slab should be constructed of a mixture which will insure a watertight slab. A mixture of 1 sack of Portland cement to 2 cu. ft. of clean, coarse sand and 3 cu. ft. of screened gravel or crushed stone, mixed to a quaky consistency and deposited to secure a dense, compact mass, should answer. If desired, as an additional precaution, the top of the roof may be coated with tar.

Wires embedded in the under side of the slab or small nailing blocks should be provided so that after the roof forms are removed furring strips can be fastened to the under side of the roof, serving as support for metal lath and cement plaster. The air space thus secured will insulate the roof so that condensation will be prevented. It is necessary that sufficient reinforcing be provided in the roof slab to carry, in addition to the live load, the weight of the earth fill placed above the roof and the roof slab should be given a slight pitch toward the front or toward each side for the proper drainage of surface water that might find its way through the earth covering.

As an additional precaution insulation of the walls may be provided by the same method or by the use of some type of hollow wall construction.

BY MR. WOLF

In the writer's opinion, the best and most effective way to insulate the concrete roof slab of an underground room in connection with a residence where the prevention of condensation and moisture appearing on the under side of the slab is desirable, is described as follows:

In the first place the concrete walls and roof slabs should be very carefully designed and detailed, with sufficient reinforcement placed so as fully to reinforce all regions of tension and thereby avoid cracks through which seepage may find its way. Then the reinforcement should be carefully placed and held in position while concreting. The concreting operation should be so arranged as to reduce the construction joints to an absolute minimum and wherever used they should be formed with a keyway. The concrete mixture should be proportioned so as to obtain as dense a mixture as possible, mixed thoroughly and carefully spaded in the forms. This concrete will be very nearly waterproof, but as an additional safeguard a good integral waterproofing compound may be added to the concrete when mixing.

Upon the finished concrete roof slab lay 4-in. hollow partition tile (bedded if necessary to produce a uniform surface) so as to cover the entire roof. All ends should be effectually closed to prevent mortar top coat from entering them and also to seal up the air spaces in the tile. After placing tile, cover it with a 1½-in. layer of 1:3 cement mortar, reinforced with a wire fabric composed of 14-ga. wires with 3-in. or 4-in. mesh placed about ½″ below the surface. This will insulate the slab very effectually and prevent condensation on the underside of concrete slab.[4] Since the fill over the slab will be only 1′ deep, the mortar topping over the tile should be waterproofed integrally or by the membrane method. In any event the top should be so pitched and sloped as to shed all seepage water very rapidly, and drains arranged to conduct water away from side-walls.

This may seem like a costly procedure, but the great variety of conditions to be met demand that unusual precautions be taken. By the use of a layer of tile covered with a layer of cement mortar the double purpose of insulating and roofing the slab for drainage is accomplished, and if properly done no trouble should be experienced from condensation or seepage.

BY MR. FULLER

The first part of the question presupposes an accumulation of water on the outside finding its way through the concrete by percolation, induced by a slight hydrostatic head or pressure, while the latter, that of sweating, may be due entirely to some inside influence and have no connection with the exterior moisture in the soil.

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[1] Engr., Infor. Bur., Universal Portland Cement Co., Chicago

[2] Prin. Asst. Engr., Condron Co., Chicago

[3] Engr., Greensburg, Pa.

[4] See Mr. Wolf's discussion in CONCRETE, May, 1914, p. 241

There are three methods of waterproofing concrete, (a) by paint coating, (b) the integral method, and (c) the membrane method. All three processes have their advocates and it might be well to consider some of their relative advantages or disadvantages.

Painting means the application to the outer surface of wall or roof of certain liquid preparations, intended to seal up the pores of the concrete, thereby making it watertight. There are many such preparations on the market, some of them having considerable merit. All of them consist of a small amount of solid matter, carried in a solution of water or some volatile oil. The oil or the water is merely a vehicle or carrier and eventually evaporates, leaving the solid matter, which is the actual insulating material, adhering to the rough surface of the concrete. The trouble with many of these preparations is that they contain an insufficient quantity of waterproofing material to perform the duties required of it. A simple solution of pulverized clay dissolved in water and applied with a brush as thick as it will stand, will fill the pores of the concrete as effectively as many of the patented preparations, on the principle that the exterior hydrostatic pressure of the water forces the fine particles of the clay into the interstices, sealing them up and making the whole impervious to water. If the wall is absolutely dry, the application of either red lead or white lead and oil will give far more satisfactory and certain results than the majority of the so-called concrete paints, but lead and oil cannot be made to adhere to a surface that is damp when they are applied.

[*Editorial Note*—Nor should linseed oil paints be used on concrete without first applying to the concrete surface a solution of zinc sulphate in water (equal parts by weight) and allowing 48 hrs. to 72 hrs. for drying).[5]]

The integral method of waterproofing consists of adding certain ingredients to the concrete when it is mixed, to combine with the cement in making the concrete impervious to water. Some of these preparations do accomplish a certain amount of good when added to a rich mixture of concrete, but the admixture of from 3% to 5% of clay will accomplish much the same result, while the addition of their cost value in cement itself will frequently produce a concrete sufficiently dense to withstand the water without their addition.

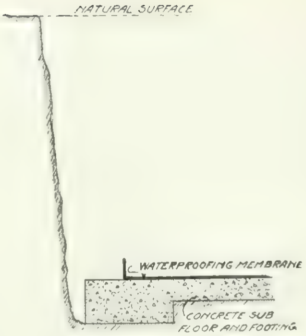

Fig. 1

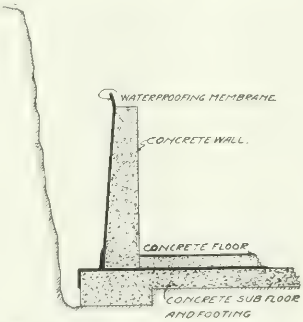

Fig. 2

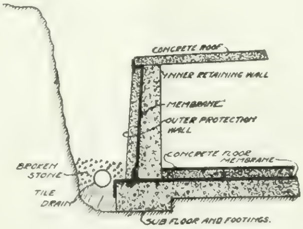

Fig. 3

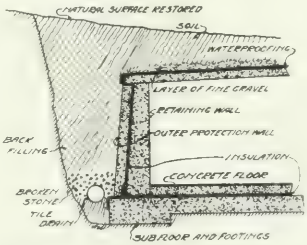

Fig. 4

[*Editorial Note*—Any value from the admixture of clay presupposes a most thorough mixing and a most finely divided clay. By many engineers it is still considered questionable practice to mix clay in concrete.]

A good dense concrete, the prime consideration of the integral method, will withstand considerable water pressure before showing signs of percolation, and if there is clay in the outside soil such percolation will stop eventually, although the wall may never become absolutely dry. Chemicals and their ingredients added to concrete for the purpose of waterproofing it have a tendency to weaken it structurally, although the quantity usually added is seldom sufficient to produce noticeable results on ordinary structures.

While these criticisms should not be considered in the light of condemnation of all such methods, for some undoubtedly possess considerable merit, none of these methods affords any protection against expansion cracks, which almost invariably occur in any mass concrete, especially if it is not reinforced.

The membrane method is a complete waterproofing if thoroughly done, affording ample protection against cracks and may be used with a low grade of concrete with nearly as good results as with the densest. It has been tested in connection with stone and brick work in addition to concrete work on some of the largest structures in the country, where the waterproofing was of vital importance. For many years it has been almost universally used in the heavy underground building operations, tunnels and subways in New York, and specialists in that line will give guarantee bond against any known head of water. To insulate a wall properly from water on the outside, it is necessary to erect a thin wall of concrete, which only needs to be of sufficient thickness to carry itself and the membrane. When thoroughly dry, apply a coat of hot pitch (not gas-tar), follow immediately with a waterproofing felt, all materials being of the best quality obtainable. Where intended to withstand a considerable water pressure, several thicknesses of felt should be used, each being mopped on with hot pitch. In New York and other places where work is done at considerable depths below the water line, as many as 20 thicknesses of felt are sometimes used, but for ordinary foundations it is seldom necessary to use more than two. After the membrane has been built up, the inner or actual retaining wall should be constructed or the process may be reversed and the retaining wall built first, as the thin outer wall is intended only as a protection for the membrane. After the wall has been finished, the roof may be added and waterproofed in the same way, but being flat or nearly so, a few inches of sand and gravel may be used instead of the protecting layer of concrete, before backfilling with the natural soil. Care should be taken that all joints in the insulation are perfect.

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[5] Concrete, Jan., 1915, p. 37

Should there be danger of water coming up through the floor, a sub floor of concrete about 3″ thick should be laid, tamping smooth with a flat-faced tamper, when waterproofing may be applied and the real floor constructed on top of it. Figs. 1, 2, 3 and 4 show the progressive steps in constructing a floor, a side wall and a roof waterproofed in this way.

As an additional precaution, a subsoil drain should be constructed around the foundation, draining to some outlet where there will be no back pressure. Four-in. or 6-in., second quality, bell-jointed sewer tile may be used, the joints being made without cement or other joint material and the trench backfilled with crushed rock or coarse gravel, broken brick or cinders. This will relieve any possible hydrostatic action of the water in the soil.

A simple modification of this plan might be used in connection with the drains. This consists of applying two or three coats of hot pitch brushed on thick, to the side walls and roof. Considerable care should be used to avoid pin holes and concrete must be absolutely dry when applied. Fig. 5 illustrates the method.

As before suggested, sweating may be caused by some inside influence entirely independent of hydrostatic pressure on the opposite side and frequently occurs in plastered masonry buildings constructed entirely above the ground, when the outside air is perfectly dry, and occasionally in a frame house. If the wall is cold and the air moist and heated, this condensation takes place very quickly and may usually be traced to insufficient ventilation. Such condensation most frequently occurs on walls backed up with earth or soil, as in the basement, owing to the difference in temperature between the wall and the atmosphere. One quite effective method of guarding against this defect is to fur out the wall with 2-in. strips and lath and plaster, thereby providing an air space for insulation. Ventilation is also an effective prevention if the inside atmosphere is not of excessive humidity. Fig. 6 shows a simple ventilator that may be used in connection with an underground room and as many as desired may be used, either in groups or scattered along the wall separately.

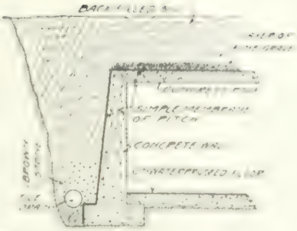

Fig. 5

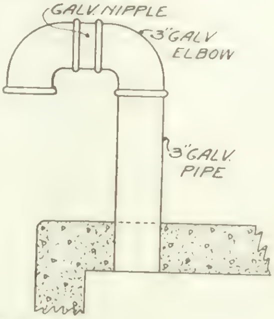

Fig. 6

The membrane method of waterproofing may be used in connection with the sub-soil drainage in protecting the cellars or other substructures and may be relied on when the work is properly done.

Cutting Reinforced Concrete Units

THE FOLLOWING QUESTION IS DISCUSSED BY:
L. C. WASON[1]
ALBERT M. WOLF[2]
W. M. KINNEY[3]

"We frequently have occasion in installing reinforced concrete floor units to cut off these members and we should like to know some quick and economical way of doing it. Chisels and hack-saw make a slow process."

BY MR. WASON

For the small amount of cutting of hard concrete with steel embedded in it that we have to do, we should use the expensive method mentioned, namely, cutting the concrete with cold chisel and sawing off the bars with a hack-saw. We have never done enough cutting to justify studying out any other methods and so we cannot from experience recommend anything of benefit.

BY MR. WOLF

In regard to a quick and economical process of cutting reinforced concrete beams in unit-built construction, perhaps the best is the use of the oxy-acetylene blow torch.

It has generally been the practice to cut the concrete surrounding the steel with cold chisels and when the steel is exposed to cut it either with a hack-saw or the oxy-acetylene flame.

In wrecking the Crane Co. building at Chicago in the winter of 1912 to make way for the new "Soo" freight terminal it was discovered that the concrete could be readily cut with the oxy-acetylene torch if the mixture and the pressure were properly regulated. In this particular case the floor girders were of structural steel (15-in. I-beams) encased in concrete. These were cut off completely with the torch in 12 min., which is rapid work, as can be readily appreciated by those who are used to the chisel and hack-saw method.

For cutting the concrete it was found that acetylene and oxygen pressures of 20 lbs. and 50 lbs., respectively, produced the best result. At these pressures the concrete seemed to disintegrate under the action of the blow-torch, as if it contained water. For such work the men should wear helmets similar to those worn by sand-blasters to protect the face.

The oxy-acetylene outfits are not low in first cost, but if much cutting must be done, they should prove the most economical, since both concrete and steel can so readily be cut.

BY MR. KINNEY

Pneumatic drills or hammers and the oxy-acetylene flame seem to be the most useful equipment for cutting through concrete and reinforcing steel, respectively. One of the first interesting records of the use of such apparatus is in connection with the wrecking of the Baltimore News building.[4] We believe that this apparatus would be very effective in cutting down the reinforced concrete floor units mentioned.

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[1] Aberthaw Constn. Co., Boston
[2] Prin. Asst. Engr., Condron Co., Chicago
[3] Engr. in Chg., Infor. and Inspec. Burs., Universal Portland Cement Co., Chicago

[4] *Cement Age*, Apr., 1911; *Concrete*, June, 1911

Prevention of Joint Marks in Stucco Over Block and Tile

THE QUESTION BELOW IS DISCUSSED BY:

WM. M. KINNEY[1]
C. W. BAUMGARDNER[2]
L. C. WASON[3]
P. P. COMOLI[4]

It has been observed that many structures built of rough concrete and of tile show the joints between the units more or less distinctly after the stucco has been applied. This is particularly marked after rain. Can you suggest, (1) the reason for this condition, (2) precautions necessary to eliminate?

BY MR. KINNEY

We have not observed this condition where the stucco is three-coat work, but have noticed it in a number of cases where the exterior plastering consists of a scratch coat and finish coat, particularly where a sand finish is used.

An experienced plasterer in Chicago, who has done a large amount of stucco work, gives an opinion that this condition depends mainly on the relative density of the block or tile and the mortar joint; also workmanship and weather conditions during early hardening. The portions of the wall surface that are more porous than others will absorb water more readily from the scratch coat unless care is taken to soak the wall thoroughly beforehand. This results in a difference in density in the scratch coat and ultimately a permanent discoloration, which in two-coat work is very likely to show through the thin finish coat.

If the block or tile be laid up in cement mortar, the latter will probably have the greatest density and consequently the joints will show light against the darker surface. If the block be dense and laid in lime mortar, the effect would be reversed. Should the weather be rainy, however, while the scratch coat is hardening, the markings may not show at all. This would be particularly true of the side of a building most exposed to the weather, which may account for the appearance of joint markings on several walls of a house where they may not appear at all on one side. This plasterer believes that the remedy is to allow the scratch coat to harden thoroughly before applying the intermediate or finish coat, preventing it from drying out by carefully sprinkling with water. In this way a surface of even density can be obtained and no joint markings will result. If the wall surface is thoroughly soaked with water prior to applying the scratch coat, it is not likely that the markings will appear, and, as already observed, the use of three-coat work is apparently another preventive.

BY MR. BAUMGARDNER

It has been our experience that discoloration at the joints is more noticeable with hollow clay tile than with concrete block, due no doubt to the fact that unless the tile are vitreous there is a greater variation of porosity. Capillary attraction causes the moisture to leave the plaster or stucco and enter the surface to which it is applied. It will be readily understood that this moisture will follow less quickly into the dense material than into the porous, with the result that in the drying out or curing process there will be a difference in color of the exterior surface.

As to the precautions necessary to eliminate this condition, in the cheaper class of construction we drench the walls until the affinity for moisture of the surface to be stuccoed has been satisfied completely. The average mechanic's idea of wetting the wall is merely to wet the surface, while the interior of the block or unit is comparatively dry. This moisture is afterward absorbed by the interior part of the unit, which does not leave sufficient moisture for the stucco. Too much stress can not be laid on the precaution of protecting the surface from drying out too fast or allowing it to be exposed to wind and sun.

When the design or construction will warrant the expense, before applying the stucco we give the walls an application of any good bonding coat, several of which are on the market. This absolutely seals the pores of the surface to be plastered, and if care is taken to see that each batch of plaster in the mixing is of the same consistency, with the same precaution for drying out or exposure, there will always result an even color in the stucco.

BY MR. WASON

When cement stucco is applied to rough concrete block, or tile, and the joints show through, especially after rain, it is doubtless due to the use of an inferior grade of stucco, one that is porous and too thin.

All are familiar with the dark streaks on old plaster ceilings where wood lath are used. This is due to the porosity of the lime plaster allowing air to pass through the plaster between the laths carrying with it dirt, which is deposited, causing dark streaks.

I believe that the lines seen on stucco surfaces are due to a similar cause, the variation in the density of the concrete and that of the mortared joints. If the stucco applied over this is porous the moisture which soaks through varies according to whether it is over a joint or over a block.

The precaution to eliminate this trouble is the use of a first-class cement stucco surface which is in itself waterproof or which has had a waterproof coating applied to it.

BY MR. COMOLI

The reason that the joints show through stucco over block is that the mortar is mostly lime with not enough cement. The proper mix for mortar is cement and sand with enough lime in it to make the mortar work plastic, say 25%. The joints should be raked out at least ¼″ to ½″ when the blocks are laid. The principal cause is one-coat work, with the cement coating applied to the wall which has a joint of much softer material, that has different absorption from the block. We find the same trouble in plastering over tile walls. One tile may be hard burnt and another soft burnt; this will have the same effect on its surface unless more than one coat is put on. If more than one coat is put on, the first coat should set at least 8 hrs. before the second or last coat is put on, but the first coat must be left rough and be wet uniformly before the next coat is put on; if this method is used, no joints will be seen after the walls have dried out. I never have any trouble but I generally put three coats on my best work with the rough-cast finish; one-coat work is not to be considered. I have a duplex building next door to my residence built of 4-in. double wall cement block and plastered two coats and rough-cast; no joints can be seen.

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[1] Engr., Universal Portland Cement Co., Chicago

[2] Gen. Mgr., Baumgardner Concrete Products Co., Tiffin, Ohio

[3] Pres., Aberthaw Const. Co., Boston

[4] Contr., Sioux City, Ia.

Correspondence: A Department in Which the *Reader* Becomes the *Writer*

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow." ☐ ☐ ☐

Ugly and Defective Concrete Work on Public Buildings ☐ ☐ ☐

A Letter from F. Webster Brady

The proverbial mud fence was never uglier than are the present-day defective and improperly faced-up concrete constructions. Especially is this ugliness emphasized where the buildings are of a class that every one is accustomed to look to for the beautiful examples of architecture, such as schools, churches, libraries and the like.

The accompanying illustration shows the shabby appearance of the concrete work on a new school building. The construction consists of a heavy reinforced concrete framework with brick curtain walls. The surfacing of the concrete frame has scaled off to a depth varying from ½″ to 2½″ or so.

One of the sad features of "rotten" concrete work on most public buildings is that the responsibility for it is seldom fixed. The taxpayers must foot the bills, and they inherit the gift of ugliness, besides.

The school building shown was erected in the late fall and in midwinter. The freezing weather was against the laying of reliable concrete, except possibly when under very close supervision. The reason for doing the work out of season might have originated from one or more members of the school board, who were in a great hurry either for glory or otherwise; or it might have come from the contractors; or again, it may have been the will of both of these parties. The public, too, carries some responsibility, aside from electing its representatives. At any rate, there was no authoritative and competent supervision of the work; the poor quality of the work stands as a witness against itself.

In public affairs there is much opportunity for building construction to be spoiled. This is because the officials are either ignorant of technical and engineering matters or they are too busy to give proper attention to the work.

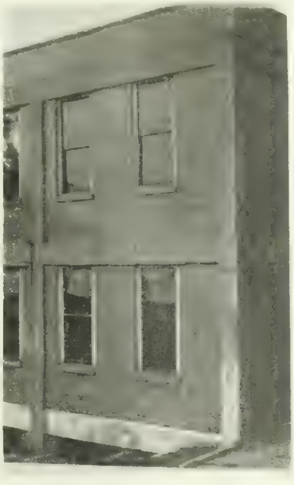
As the danger from these and other causes is so great, and as concrete work is more easily spoiled than either stone or brick work, the public would be better off in going slow by endorsing the use of concrete in public buildings.

The concrete used in the school building mentioned contains whole gravel aggregates, many of these being larger than a hen's egg, and so smooth that the cement has not stuck to them. (Probably dirty aggregate—Editors.)

This sorry case suggests these questions: Can reliable concrete construction be done in freezing weather? (Yes—Editors.)

Can the surface finish, a kind that is pleasing in appearance and permanent, be made directly in the forms so that no subsequent plastering is necessary? (Yes—Editors.)

[Editorial Note — No one will blame Mr. Brady for not liking the appearance of this job. It is hardly a fair sample of concrete school or other building construction. As likely as not our genial friend Hap Hazzard had a hand in it somewhere.]



How NOT to do a Concrete Job

Beach Shells as Concrete Aggregate

A Letter from A. Morgan Smith[1]

In the Aug., 1915, issue of Concrete I read with interest the discussions of the question: "Can you give me definite information on the reliability of beach or sea shells as a concrete aggregate?"

Last winter while on the southwest coast of Florida I had occasion to make some reinforced concrete designs, and to get definite information as to the reliability of shell concrete I got from the Gulf Coast clean, fresh shells (not live shells) that would pass through a 1-in. mesh—the most would pass through a ½-in. mesh. The sand was from the pine woods.

The specimens I made to be crushed were 4.87-in. cubes; age when crushed at 42 das.

Cube 1 failed at 26,000 lbs. or about 1,100 lbs. per sq. in.
Cube 2 failed at 28,000 lbs. or about 1,180 lbs. per sq. in.
Cube 3 failed at 32,000 lbs. or about 1,350 lbs. per sq. in.
Cube 4 failed at 31,200 lbs. or about 1,320 lbs. per sq. in.

The sand used in cubes 1 and 2 was white surface sand and that in cubes 3 and 4 was yellow sub sand. The mix in all four cubes was 1:1.6:2.6 cement, sand and shells.

With the apparently unlimited supply of beach shells on some parts of the southwest gulf coast of Florida and at a cost from $1.00 to $1.50 per cu. yd. delivered to almost any dock, shells should encourage the use of concrete on the south end of the Peninsula. Using a factor of safety of five it will be noted that these tests will allow a working compression stress of about 230 lbs., which is a little more than ⅓ of what is usually used for stone or gravel concrete.

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[1] Architect, Mt. Lebanon, Pa.

More About Stresses in Concrete Beams and Slabs

In Dec., 1915, Concrete *presented an article by Robert B. Melvin advancing theories of concrete beam and slab construction opposed to the generally accepted theory that there exists in these members a neutral plane and areas of tension and compression.*

The soundness of Mr. Melvin's theories is questioned in letters from Edward Godfrey and C. A. P. Turner. Mr. Melvin supports his contention by describing and interpreting a partial failure of an actual concrete structure.

A Letter from Edward Godfrey[1]

In your Dec., 1915, issue, Robert B. Melvin gives a theory of reinforced concrete slabs and a test purporting to show newly discovered properties. This article is either ingenious or ingenuous. Let us hope it is the latter.

These "discoveries" would not be so bad if they were not taken seriously, but so many errors have been taken seriously that it behooves the profession to examine the teeth of new theories.

Mr. Melvin is apparently under the impression that a fixed end beam is one whose ends are not only held against deflection but also fixedly held against horizontal motion. A fixed end beam by his theory would have an unlimited capacity of the ends to resist tension. This is not the truth. A fixed end beam is merely held horizontal at the ends. It may be merely balanced at the supports, and the supports may be high columns not capable of resisting any horizontal pull.

Mr. Melvin's test merely shows what three concrete covered harp or fiddle strings would carry. It has no relation whatever to the carrying capacity of a slab, for he says that the slab was broken clear across. The nearest thing to this is a test published some years ago where the slab was reinforced with chain. The "fiddle" was a steel box of tremendous strength but the details of that box were carefully concealed in the article.

The harp or fiddle used in Mr. Melvin's test was (judging from the photographs) six or eight times as big as the slab in cross-section and probably 20 times as heavy in weight. This slab probably failed under a small load, but after this the "post mortem" strength would be largely a function of the end anchorage, for the rods are shown to be sagged away down in the test, acting like a suspension bridge. Buildings are not made in this way. Idle construction twenty times as heavy as the slab cannot be supplied with every slab that is loaded.

A circus net will support a large load if a goodly number of husky hands are pulling out on its circumference. But a circus net stretched under a floor slab could only serve to catch the debris after the slab had broken.

The flat slab advocates have put over this same trick on the gullible engineering profession. They load a spot in a large floor, one or more interior bays but never a complete row of bays across a building. I have shown experimentally that the result is surprising when a complete row is loaded and a flat slab is compelled to assume a cylindrical shape instead of being dished in one panel.

A Letter from C. A. P. Turner[2]

In your issue of Dec., 1915, in an article by Mr. Melvin, you state that Mr. Melvin takes a stand in direct opposition to commonly accepted theories of floor design. His diagrams are intended to show a difference between simple beam theory and continuous beam theory which, upon a critical analysis, it will be seen does not in fact exist. Nevertheless Mr. Melvin has pointed out a radical inconsistency in the requirements of building ordinances regarding shear. For example, the shearing values allowed for the continuous beam and the simple beam under nearly all building codes are the same. The mathematical beam theory, however, fully worked out, shows that different requirements should logically be made between the simple and the continuous beam.

Looking at the continuous beam in the light of its makeup it consists essentially of a double cantilever extending from each side of the support and a suspended span between the cantilever. Now the double cantilever is in the same position as regards horizontal shearing deformation as an inverted simply supported beam of the length of the cantilever. In the simply supported beam the maximum horizontal shearing deformation occurs at the end. The same is true of the double cantilever and these horizontal shearing deformations fit in to those of the suspended span portion.

The mathematical treatment of the shear in continuous beams is not given in the majority of theoretical treatises on concrete. It will, however, be found correctly discussed in the treatise by Eddy and Turner, on pages 108 and 109, where it is shown that the diagonal tensional deformation brought about by the vertical and horizontal shear is only half as great for a given unit shear on the section in a continuous beam at the support as it is in the simple beam. This fact, readily brought out by the complete mathematical theory, seems to be the basis of Mr. Melvin's erroneous conclusion that there is no neutral plane with the conditions of bending found in the continuous beam. The conditions which he finds are those which theory predicts and are in accord with the theory, and so in no wise constitute a contradiction of that theory and it forms no basis for his conclusions. The relation of thickness to span is also investigated in the same treatise on pages 85 to 87, and conclusions quite different from those Mr. Melvin would draw are arrived at from the same acknowledged state of facts.

A Letter from R. B. Melvin[3]

It is evident from the tone of Mr. Turner's criticism that he did not go into the whole matter of my theory. He agrees with me concerning horizontal shear, but sticks tight to the neutral plane theory, ignoring the more important points of the discussion and the fact that "a curved line between two points must be longer than a straight line connecting the same two points."

The assumption that a continuous beam is made up of a double cantilever supporting a simple beam at the ends, as mentioned by Mr. Turner, is not only an unreasonable assumption, but deliberate sidestepping of the true conditions which we know to exist. The ends of this combination cantilever and simple beam are absolutely fixed.

If a combination of beams could be constructed according to the cantilever-simple beam theory and made to act as such under load, the ends of the cantilevers and the ends of the simple beam would pull away from each other.

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[1] Civ. Engr., Pittsburg

[2] C. A. P. Turner Co., Minneapolis, Minn.

[3] Cleveland

The action of the platform beams under load, after being apparently destroyed by shrinkage, verifies the results of my test and proves conclusively that the value of a fixed end span is its tensile value.

THE EFFECT OF SHRINKAGE ON CONCRETE BEAMS

The purpose of the following data is to show by two actual cases of concrete beam shrinkage:

1. That the simple beam or beam with one or both ends free, will deflect due to shrinkage of the concrete, to such an extent that the connection of beam and support is destroyed.
2. That the compressive area of the concrete in a fixed end beam is unnecessary and that it does not come into play when the beam is supporting its load.
3. That the steel reinforcing carries the load and that the bond between steel and concrete can be relied upon to fix the ends.
4. That the action of the simply supported and that of the fixed end beam are entirely different, as shown by the different conditions of failure of the concrete, due to shrinkage.

Action of Beam of Two Spans—Fig. 1 shows an outside platform supported by a beam of two spans. Cracks, as shown, resulting from contraction of the concrete, extend *through* the members, separating the concrete of the beam from the columns.

The horizontal cracks over supports were caused by the contraction occurring at *a* and *b*, Fig. 1 having a tendency to bend the beam into the form shown in Fig. 2 and lifting the beam from the supports at *c* and *d*.

The cracks at *c* were caused by the combined shear and vertical tension occurring at the bearing ends of beam when the beam concrete contracted, thereby deflecting the beam, shortening the horizontal distance between the ends of beam as at *e*, Fig. 2. There are no vertical cracks in this beam.

Action of Beam of Ten Spans—Fig. 3 shows the third span from end of an outside platform, supported by a continuous beam of 10 spans resting on columns 10′ apart.

The cracks shown at *a* and *b* are the result of combined shrinkage from drying, contraction due to temperature change and the dead load.

The crack at *a* is about $1/16''$ wide at top, tapers to a hair at the steel, extends through the beam, completely separating the compressive area, and occurred before any live load had been applied. The application of a distributed load of four tons over this panel had no visible effect in changing the width of cracks and the cracks did not close up as would be the case in a simple beam. All spans in this series except the end spans show cracks similar to Fig. 3. There are no vertical cracks in the end spans but the horizontal cracks over end supports are the same as shown in Fig. 1.

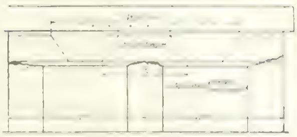


Fig. 1—Diagram Showing Cracks in Two-Span Platform

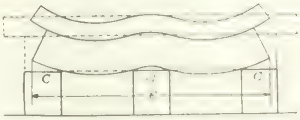


Fig. 2—Diagram to Illustrate the Tendency of Beam Under Load

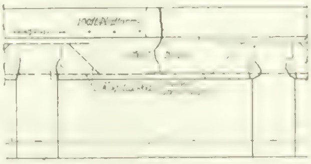


Fig. 3—Diagram of Cracks Occurring in Continuous Beam

The bearing value of the concrete in this beam at columns, as shown at *b*, Fig. 3, is entirely destroyed. The entire load is supported by the steel rods acting in tension and the concrete is not acting in compression but is merely unnecessary dead weight.

It will be noted in Fig. 3 that at the extreme fiber of points where maximum horizontal compression should occur, according to present assumptions, the cracks are widest, and taper as they approach the steel or points of maximum tension. This condition is apparent after a live load is applied the same as under the dead load.

Another point to be noted is that this span without the opposing force of compression still carries the load for which it was designed, and it would seem from this condition that a fixed end concrete beam, after apparent destruction, will still do the work for which it was intended.

Lining the Shafts of Mines—a Downward System

According to the Engineering Supplement of the London *Times,* a paper by Marcel Gillieaux, read before the Mining Institute of Scotland, described a method of lining the shafts of mines from the top downwards by means of concrete block of special shape.

He remarked that if it were feasible to build a concrete lining downwards—that is, from the top to the bottom, following step by step the deepening of the shaft—it would be possible to dispense with all temporary supports, the defective junctions between the sections in which it must be constructed would disappear, and the workmen, being in security, would work better and faster. So far only incomplete and unsatisfactory solutions of the problem have been proposed, more complicated than the old methods, while possessing all their defects.

Concreting downwards can, however, be carried out by using block of such a shape that they are capable of self-suspension, and to that end the author has devised a form of construction in which the segments are of Z-section. Each section is hooked on to the next higher section, and thus, on account of the weight of the block, a closer joint is made than is possible in the ordinary way. The method dispenses with all temporary shoring, expensive bolts and ties and defective junctions, and realizes the ideal of a homogeneous wall. A strong crown-ring is let into the standing rock at the head of the lining, and when the sinking has progressed sufficiently, a series of segments of special shape is suspended from it to form the first ring of the tubing. Additional rings are then hooked onto those already in position, the rib of the segment that forms the upper hook being directed outwards, while that which forms the lower hook is directed inwards. When several rings have been put in position, the annular space between the lining and the shaft wall is plugged, and a semi-fluid mixture of cement and sand is injected through holes provided for the purpose. When the cement has set it binds the lining firmly to the external rock, and additional blocks can be hung on below without fear of straining the upper portion. The blocks are reinforced with S-iron bars forming a double hook extending from the top to the bottom rib, with auxiliary simple hooks arranged symmetrically to the first-named in the nose pieces and the throat.

Organizations

American Concrete Institute, John M. Goodell, Acting Secretary, 1418 Walnut St., Philadelphia, Pa.

American Concrete Pipe Association, Secretary, E. S. Hanson, 538 S. Clark St., Chicago.

American Highway Association, Chas. P. Light, Field Secretary; Colorado Bldg., Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C. Convention.

Association of American Portland Cement Manufacturers (Portland Cement Association), J. P. Beck, Gen. Mgr., 111 Washington St., Chicago.

Cement Products Exhibition Co., 208 S. LaSalle St., Chicago, Ill.; Robt. F. Hall, Secy.

Mid West Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb.

Second National Conference on Concrete Road Building, J. P. Beck, Secy., 208 S. LaSalle St., Chicago.

New Books

Engineering as a Career—A series of papers, by engineering specialists edited by F. H. Newell and C. E. Drayer, cloth, 5″ x 7½″, 214 pp., G. Van Nostrand Co., $1.00.

This book is valuable as a guide to young men and to those having to advise boys in the choice of a career. The varied branches of the engineering profession are described in readable form and an idea is given of the inducements which the engineering profession can offer to the technical graduate.

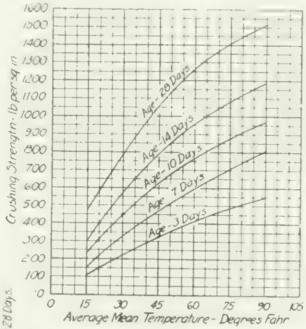
Industrial Uses of Fuel Oil—By F. D. Dunn, 5″ x 8½″, 232 pp., illust., cloth, Technical Publishing Co., San Francisco, $3.00.

This book collects in small space details of the actual use of oil as a fuel in various industries. Chapter 6 deals with fuel oil in the clay, the lime and the cement industry. Details of lime kilns are given, showing the arrangement of burners and reports of quantities of fuel used for burning given quantities of lime are given. Diagrams are given showing the general arrangement of storage and piping in connection with the burning of Portland cement, also factory records involving the use of fuel oil.

Influence of Temperature on the Strength of Concrete. Bul. 81, Eng. Exp. Sta., Univ. of Ill. By A. B. McDaniel, paper, 6″ x 9″, 24 pp., illust. Free.

This bulletin presents a study of the data obtained from three series of tests of concrete cubes and cylinders These specimens were stored under temperature conditions varying from 25° to 90° F., and were tested at various ages up to 28 das. Curves are presented to show the relation between strength and age for different temperature conditions, and also the relation between strength and temperature at different ages. The results are summarized in a set of curves which show the percentage strength of concrete at different ages and under different temperature conditions to that at an age of 28 das. and under a normal temperature of 70° F.

The results of the tests made under freezing temperature conditions are of especial interest, showing the gradual and slow gain in strength under a storage temperature slightly below freezing, and the disintegrating effect of alternate thawing and freezing temperatures.



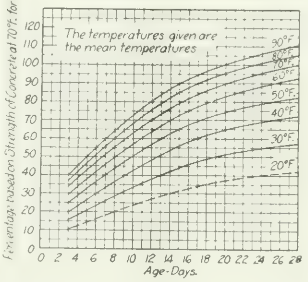


Fig. 1—Relation of Strength to Temperature at Various Ages

Fig. 2—Percentages of Strength for Different Ages

The bulletin will be of value to the contractor, engineer and others engaged or interested in construction work for information regarding the strength which may be expected of ordinary concrete under different age and temperature conditions and the time for the removal of the forms.

Simplified Reinforced Concrete Mathematics. By Melvin D. Casler, B. E., cloth, 5″ x 7½″, 66 pp., illustr., D. Van Nostrand Co., N. Y. C., $1.00 net.

This book seems to meet the need for a simple concise statement of the derivation of the essential formulas used for the design of concrete structures and their application to practical work with a minimum number of calculations. The formulas are derived for general application to beams subjected to direct longitudinal stress in conjunction with transverse moment, also to eccentrically loaded columns and to arches.

Special effort has been made to simplify without loss of accuracy. By means of simple charts, one function of a member being given the others are instantly shown. The use of the concrete slide rule is explained. A general chapter on practical design is by no means the least valuable feature.

Bungalows, Camps and Mountain Houses. By Wm. P. Comstock and C. E. Schermerhorn. 2nd. ed., revised, cloth, 7½″ x 10″, 125 pp., 200 illust., 80 designs. William T. Comstock Co., N. Y. C., $2.00.

The book is a compilation to which 32 recognized authorities on bungalow design have contributed. An article by Mr. Schermerhorn, A. A. I. A., gives in condensed form the requirements for bungalow planning and includes a number of detail sketches with a plate showing 22 typical layouts.

The book is divided into three parts: 1—Bungalows, 2—Bungalows of the cottage type, 3—Camps, Lodges and Cabins. It is exceptionally well printed, the halftone illustrations being on heavy plate paper the text and sketches being on white antique paper. The binding is substantial and attractive.

Purchasing. By H. B. Twyford, cloth, 6″ x 9″, 236 pp., 112 Figs., D. Van Nostrand Co., N. Y. C., $3.00 net.

The importance of purchasing is much greater than the available literature on the subject would lead one to believe. This book reduces the machinery of purchasing to an exact science; it gives, by means of test charts and forms that have been used by large buyers, a comprehensive treatment of buying routine and records.

No less valuable are the chapters on purchasing principles, functional position of purchasing, ethics of buying, the purchasing agent and the purchasing department. In these chapters are discussed the factors which should govern buying, the psychological and personal relations between buyer and seller, the qualifications of the buyer and the organization of his department.

The book seems to cover its subject in a comprehensive and interesting way.

The Essentials of Safe Building Construction—Society Advocating Fire Elimination, Cleveland, Ohio; paper, 6″ x 3½″, 8 pp.

A pamphlet on the Essentials of Safe Building Construction. It deals with the subject with a view to eliminating hazardous construction methods and securing more uniformity in building codes. It does not go to such extremes as to be unpractical and is well worth some study by those intending to build or concerned in the adoption of building codes.

Detailed Formulas and Directions for the Manufacture, Use and Care of Sanitary Composition Products—The Town Supply Co., Cleveland, paper, 7¾″ x 5¼″, 26 pp., illust., price $3.00.

The use of magnesite or so-called "composition" floorings has not been widespread, largely because the formulas have been held as trade secrets. This publication gives formulas and directions for the use of this material. The value of this book is not to be measured by its size, for while only a pamphlet it contains formulas which have been sold at many times its price.

The Model T. Ford Car—By Victor W. Page, cloth, 5″ x 7″, 300 pp., illust. The Norman W. Henley Publishing Co., N. Y. C., price $1.00.

The publishers of this book also issue a chart, 25″ x 38″, printed on heavy bond paper, price 25 cts., intended to help Ford owners and drivers in the location of Ford engine troubles.

Masonry as Applied to Civil Engineering—By F. Noel Taylor, cloth, 8¾″ x 5¾″, 230 pp., 212 illust. D. Van Nostrand Co., price $2.50 net.

Cement Paste Joints for Iron Pipe

The successful use of cement paste joints for cast iron water mains is described in *Engineering News*. The practice seems to have originated in the water department of Long Beach, Cal., about 10 yrs. ago. Clark Shaw, Supt. of the Long Beach water works, says that the cement joint is cheaper than the lead joint and is tighter and more permanent. After the pipes have been connected a ring of dried jute is inserted in the bottom of the bell and the bell filled with neat cement paste. It is essential that this paste be mixed with only enough water to moisten it, but not enough to make it soft. After the bell is filled with the paste it is packed with a long calking tool, like that used for calking a lead joint. If the paste is of the right consistency it should pack under the tool until it is almost as hard as lead. After the first calking the joint is refilled with paste, which is again packed solid with the calking iron. This is repeated a third time. The joint is then neatly rounded off with a collar of 1:1 cement and sand. The cement is allowed to set for 48 hrs. before water pressure is turned on the pipe. The only lead joints now being used in Long Beach are those on pipe which have to be at once submitted to water pressure. When it is necessary to take up pipe it is found that the joint is more easily broken than the lead joint. A section of the cement on top, about 60° wide, is chipped out to the bottom of the bell, and the joint is then readily broken. The material for a lead joint costs about 29 cts. and the material for a cement joint 3½ cts. This is with lead at 5½ cts. per lb. for a 4-in. pipe joint.

Concrete Reservoir Floor Used for Dancing

The question of treating concrete floors to make them suitable for dancing occasionally comes up and was recently discussed in CONCRETE.[1] The city of Cincinnati has as a part of its waterworks system, a reservoir of considerable size known as the Eden Park reservoir, which has recently been re-lined with concrete.[2] As this reservoir is not required for regular use but is held as a reserve supply, it was recently emptied.[3]

The opportunity which this afforded was taken advantage of in connection with a great municipal picnic held upon Labor Day. It is said that about 12,000 couples were dancing at one time on the floor of this immense reservoir.

It is interesting to note in this connection that no special treatment was given the floor for this purpose. About 14 men were employed in cleaning up the floor for one day preceding the picnic. The water had been let out two or three days before, so that the surface was dry. It is supposed that this is the largest artificial dancing space ever utilized. In this connection it is interesting to note that Cincinnati has been providing concrete dancing floors in various parts of the city for the last three years. Concerning this William Hodgkinson writes:

> Ordinarily the floor should be finished with a smooth troweled surface. Out of doors the platforms are blocked in suitable size to overcome the effects of expansion.
>
> More often than not, no treatment is given the floors but in some instances preparations of paraffin wax are sprinkled on the floors and worked in by the dancer. This gives a very smooth, slippery surface, but we consider it unnecessary.
>
> We have no complaints concerning the floors, our only difficulty being to supply the different communities with both indoor and outdoor platforms.
>
> Our latest one is 80′ x 50′. This is in an open park with no cover. A pipe is set in a pipe socket set in concrete block, about 2′ 6″ to 3′ outside of the platform. Into this, on dance nights, we slip another pipe of about 2″ diam. with a T on the top, through which we run a rope about 3′ to 3′ 6″ from the ground. This merely answers the purpose of keeping crowds back, allowing us to handle them properly.

According to the San Diego *Union* a new concrete highway between Elsinore and the San Diego county line, which is a section of the state highway, is completed and has just been thrown open to travel. The completion of the road practically fulfills the state's undertaking to construct a highway between Murietta and Temecula.

The loss of the German cruiser *Emden* forms one of the interesting episodes of the war. The wrecked sea-raider which was beached after the Australian cruiser *Sydney* defeated her in a hot running fight, has "the gaping holes in the hull filled with reinforced concrete." A syndicate of Sydney contractors received permission to raise and reconstruct the wreck.

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[1] July, 1915, p. 34

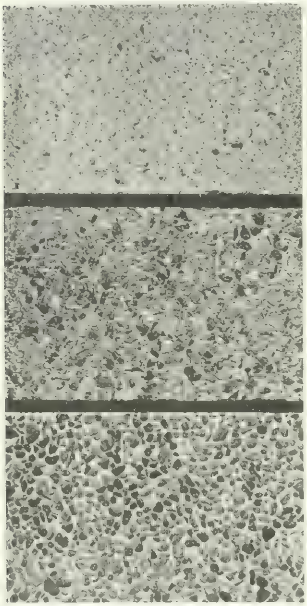
[2] See CONCRETE, Mar., 1915, p. 134

[3] It is understood that the reservoir has not given entire satisfaction and that repair work is being undertaken. EDITORS

[4] Secy., Board of Park Commrs., Cincinnati

New Equipment, Methods and Materials:
New Tools with Which the Industry Works ◻ ◻

The commercial development of machines, tools and materials, and the new methods which their use involves have a most important part in the progress of the concrete field. Announcements of such developments, particularly in reference to their demonstrated importance in actual practice, are welcome. The Editors will select for publication that material which conveys the information of most practical value to the Reader, without regard to other considerations.



Sample of Rubbed Surface (Top) and Two Brushed Surfaces by New Process in Stone Manufacture

New Process in Concrete Stone Manufacture

There was an exhibit. at the Chicago Cement Show last month, of concrete stone involving some new manufacturing methods. Not only were the products shown of unusually attractive appearance but the methods involved promise interesting development, particularly in view of the low cost at which it is said to be possible to produce a stone with good surface and of a character which should appeal to architects. The exhibit was that of the Tower Concrete Products Co.[1]

The idea involved is in the use of a wet facing mixture of selected aggregates, backed up with a drier mixture which is tamped into the face and which is depended upon to absorb the surplus moisture from the face. The product is made in dimension stone molds or in standard block machines, as may be desired, with a lining over the surfaces where the facing is to be applied of a heavy paraffined paper. This paraffined paper lining not only covers the face but extends vertically in the mold to a point a little higher than the depth of the wet facing mixture. With the paraffined paper it is possible to remove the product at once from the mold or the machine as in ordinary tamped work and after a few hours of curing to remove the paper from the products for surface treatment. The secret of success in the process, which is patented, lies in the quality and character of the paraffined paper. Paper of an ordinary grade is apt to wrinkle when the wet facing is applied and leave a corrugated surface on the stone. The work of the Tower Co., however, is shown as proof of the success of the methods which have been employed in a purely local territory in the manufacture of stone for some little time.

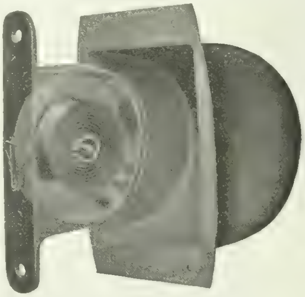
The paraffined paper, having a very smooth surface, makes it possible after curing the stone to expose the aggregate in the facing with a minimum of rubbing with carborundum brick. The same method is used not only for a rubbed finish but in products in which a brush finish is used to give a coarser texture, exposing the aggregate and at the same time leaving a firm, dense matrix of mortar which is practically waterproof. The process is being developed and rights of manufacture will be sold by the Presto-Granite Products Co. The accompanying illustration, showing three types of exposed facings, gives an idea of the character of the work.

A Spring Sash Balance for Concrete Buildings

Satisfactory window frames and devices for balancing sash in concrete buildings have been something of a puzzle; while the usual type of box frame has been extensively used, it is often felt that simpler construction should be available.

The illustration shows a spring sash balance[1] that has been in use for a long time in frame construction and has recently attracted attention in connection with concrete buildings. It will be noted that the phantom view shows the balancing to be done by a coiled spring which is wound within a drum around which a metal tape is wound.

By using this balance a plank frame only is required and a special housing is applied to the back of



The Pullman Sash Balance and Special Housing the frame covering the pair of balances, keeping them free from the concrete.

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[1] Indianapolis

[1] Pullman Mfg. Co., Rochester, N. Y.

It is said that the cost of the balance over the ordinary sash weight is saved in the construction of the window frame. The reduction in the amount of wood required in frames and the smooth operation secured from the spring balance are points in its favor.

Simple Operations in Making Silo Staves

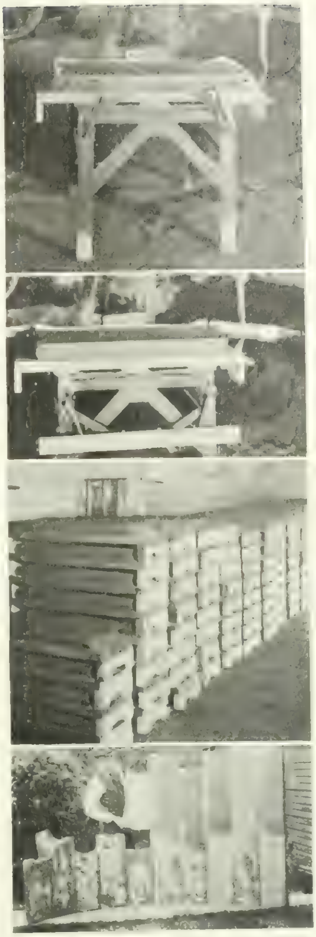
Silo staves are simple units. Good materials, well mixed, well placed and properly cured seem the only considerations. The operations in making and setting up staves with the Swan[1] units are practically all shown in the accompanying illustrations. The staves are 30″ long, 10⅝″ wide and 2½″ thick.

Fig. 1 shows the machine with pallet on and the mold together as the stave is being made. Snaps on the front corners hold the mold together. The mold and the frame are made of cast iron, weigh about 200 lbs. and are intended to be strong enough to be used under an automatic tamper.

Fig. 2 shows the mold open with stave on the pallet, ready to be carried to the curing room. When the front snaps are released the front of the mold drops down on a hinge. The back of the mold is stationary on the frame, but both sides of the mold swing out sideways, working on hinges. The pallet is made of a plank, hollowed out in the center to make the stave on a curve.

Fig. 3 shows the staves as they are piled up in the curing room.

Fig. 4 shows a few of the staves set up, showing the joints as for silo construction with tongues and grooves.



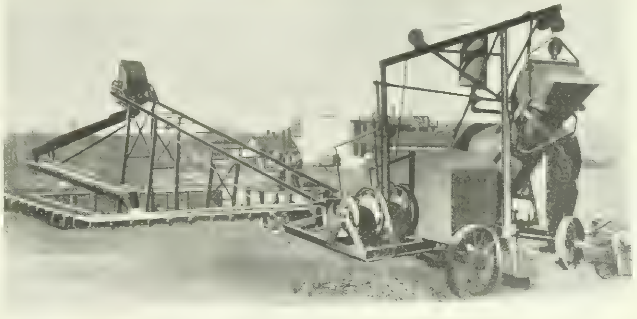
Figs. 1-4—Making, Curing and Erecting Swan Silo Staves

Spouting Equipment for Small Work

A new development in concrete distribution is shown at Fig. 1. This equipment consists of a portable track and skip[2] provided with means for easy adjustment to meet working conditions and a 2-joint spouting section.

The skip is operated by a hoist attached to the mixer and is operated by the mixer engine. The operation is apparent, the concrete being deposited from the mixer in the skip and drawn up the incline, where it is dumped into the spouting system for distribution.

The capacity is said to be from 8 yds. to 12 yds. loose material per hr. The equipment, while light enough to be readily portable, seems to be substantial and promises to save much labor and to increase speed on foundations and other work for which it is adapted.

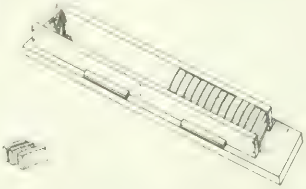


The Jaeger Spouting Plant

Simple Mold for Silo Block

Home-made equipment is apt to be much less desirable from the standpoint of convenience and not so economical for continued use, yet occasions arise which make the home-made devices good things to know about for emergencies or for small jobs not warranting elaborate outlay for standard equipment. On that basis a suggestion for making silo block for which this magazine is indebted to the Iowa Experiment Station, is quoted here as published in a *Bulletin* of the station.

> The illustration shows a method of making concrete silo block in large quantities without the use of expensive forms, one which enables a wet mixture of concrete to be used. This scheme of making block was suggested in a conference with Prof. H. H. Musselman, of Michigan Agricultural College. The idea has been tried out at the Iowa Station and has been found to be practical. In brief, the scheme consists in building up a box form the depth of which is to be the height of the silo block. A quantity of steel division plates is provided, made from No. 16 steel plate and rolled to the curvature of the silo. These plates are spaced in the form by nailing wooden blocks to the sides of the form.
>
> If 4-in. weather boarding or lap siding is used, the radial cut for the ends of the block will be provided and the dividing plates spaced 4″ apart for 4-in. block. The dividing plates are covered with heavy wrapping paper and placed in the



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[1] Swan Concrete Stave Silo Co., Cassopolis, Mich.

[2] Jaeger Machine Co., Columbus, Ohio

form. The form is then filled with a wet mixture of concrete. The paper, where it laps over the top of the dividing plates, is then cut open with a knife and the dividing plates withdrawn and immediately used again.

Several hundred block may be made in a day by this method and the outlay for forms is reduced to a few dollars.

A Radical Change in Expansion Bolt Construction

An expansion bolt shield[1] in a single unit is being placed on the market. The screw enters the shield centrally and emerges at the side, the screw being forced directly against the side of the hole and giving a very powerful expansion.

THE DIAMOND X. EXPANSION SHIELD

Face Plates to Make Block Like Brick Work

The feature of a new face plate,[2] adapted for use with various block machines, is to enable manufacturers when their trade demands to produce block so scored as to give the appearance, when laid up, of a brick wall. The success of the deception will depend a great deal upon the care taken in laying the block so that the real mortar joints will be even to correspond with imitation joints in the face of the block. The producers of the plates also make a face-down block machine to which the special plates are particularly adapted.

A Simple Method of Grading Aggregate

While much attention is being given to the study of aggregates by experts, any method that will help the man in the field to judge, at least approximately, the best mixture, is valuable.

Prof. A. B. McDaniel[3] suggests the following:

First, pass the gravel twice over a ¼-in. mesh screen to separate the sand and gravel or lesser and coarser aggregate. Then secure a stout cylinder such as a tile or section of pipe having a diameter of about 12″ and a depth of from 12″ to 18″. Weigh out 1 unit of cement, 2 units of sand and 4 units of gravel, being careful to have the whole mixture less than enough to fill the cylinder. With a cylinder of the size stated above, 15 lbs. of cement, 30 lbs. of sand and 60 lbs. of gravel would give suitable quantities. Mix the materials together and then add about 10% of water, to make a concrete of about normal consistency. Tamp the concrete into the mold, leaving the upper surface smooth and horizontal, and then measure the distance of the upper surface of the concrete from the top of the cylinder. Dump out the concrete and clean the cylinder and the tools. Using the same amount of cement, but different proportions and amounts of sand and gravel, make up other batches into the cylinder in the same way. Tamp each batch into the cylinder in the same way and measure the depth of concrete as described for the first case. Several trials can be made and the proportions determined that give the least depth of material in the cylinder.

Shrinkage of Reinforced Concrete

F. R. McMillan, of the University of Minnesota, has been making a number of tests to determine the shrinkage and time effects in reinforced concrete. According to a summary of his paper by A. A. Klein, published in *Chemical Abstracts*, the following results were obtained:

Beams tested were 5½″ deep, 30″ wide and 12′ long between supports. Concrete consisted of 100 lbs. cement, 2 cu. ft. sand, 4 cu. ft. stone, hand mixed. Results show that shrinkage of ¾″ to 1″ in 100′ can be predicted when concrete is exposed to the ordinary dry air of a heated building. Changes in moisture content will retard shrinkage and even cause swelling. The yielding of concrete under compressive stress with time is greater as the unit stress is greater and goes on indefinitely. The deformation was found to be 3-5 times that produced immediately upon application of load. The time yielding under stress combined with shortening due to shrinkage may result in deformations 15-20 times those expected from calculations.

Small Mixers Prove Economical on Large Work

The growing use of tower and spouting systems having a centralized concrete plant sometimes results in a tendency to overlook conditions in which a less expensive construction plant would prove economical. This condition is illustrated by the construction methods used in the basement of the Methodist Book Co. building in Chicago. The foundations of this building are designed to carry four stories and to accommodate printing presses. A basement 12′ 6″ below sidewalk level is provided.

Pier footings, which are on concrete piles, are 9′ x 9′ at the base. Basement walls are approximately 13′ 6″ high and the building is 125′ x 125′. The fact that this building is located on a corner and adjoins an alley, permitting operations to be conducted on three sides of the structure, suggested the use of small portable mixers, two of which were used.[1] As concrete could be spouted from these mixers a considerable distance by moving them occasionally all the concrete in the retaining walls on the two streets and alley sides and a considerable part of the concrete on the inner retaining wall were spouted directly into the forms. The depth of the basement was such that two rows of pier footings could also be spouted directly from the mixers. Two rows of pier footings were thus constructed on three sides of the building and the remaining pier footings were poured by the use of concrete carts which received the concrete from bins into which it had been spouted. Very little material was carted more than 50′.

Architectural Ornament In Reinforced Concrete Buildings

Architectural ornament is discussed by Frank H. Heaven in an article in *Concrete and Constructional Engineering*, England, on "The Effect of Reinforced Concrete Upon Architectural Design." He says:

It may be thought, perhaps, that reinforced concrete can have little or no influence upon the architectural ornament of a building, but its employment might greatly add to the grace of our building by producing a greater degree of light and shade upon elevational design by giving a large projection to strings, cornices, etc. The limits of stone or other granular material when in projection are well known, but ornamental reinforced concrete work could be employed to advantage where other materials fail. The Greek temples of old owe a great deal of their charm to the effects of light and shade cast by their projections. The sun, however, does not treat all lands alike. In southern Italy the proportioned cornice of the Orders produced the desired effect by reason of the high altitude of the sun, but the use of the same projection in England has an altogether different effect, due to the lower angle at which the light from the sun can produce shadows. Many of our monumental buildings, for that very reason, are almost shadowless. The architects of the Renaissance in Northern Italy recognized this fact and crowned their Palazzi with great overhanging cornices. The Americans, too, have seen the necessity for a deep shadow to give repose to their large scale buildings and obtain the same by the use of zinc or iron cornices of great projection, painted to imitate the material in which they are working. The use of reinforced concrete in decorative cornices would be legitimate construction if we recognize the material and give the member its true value in relation to the whole design, and the deeper shadow cast by greater projections on our building would be appreciated.

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[1] Diamond Expansion Bolt Co., N. Y. C.

[2] New Departure Mfg. Co., Indianapolis

[3] University of Illinois, Urbana, Ill.

[1] Standard Scale & Supply Co., Chicago

Concrete

Vol. 8 *Detroit, April, 1916* *No. 4*

The Steel Market and Concrete Construction

THE soaring price of steel is affecting the concrete industry from numerous angles. The high price and the impossibility of securing structural steel are turning the attention of many designers to reinforced concrete for relief. This is particularly true in the case of long girders and roof trusses.

Reinforcing bars have advanced sharply and, while some manufacturers of fabricated reinforcement are having difficulty in securing sufficient supplies to care for their demands, others report their ability to make prompt deliveries where traffic conditions permit.

Wire reinforcement and expanded metal are naturally advancing in sympathy with the advance of raw material, with prospects of further increase. Deliveries are reported as being fairly prompt at the present time.

A. I. Findley, editor of *The Iron Age*, writes CONCRETE:

> Architects have reported recently an increasing number of their clients who have abandoned building projects requiring structural steel or are attempting to work out designs in reinforced concrete, yet there is a good volume of structural steel work before the trade. Railroad bridge work has been of more consequence lately and there is an unusual amount of industrial construction. The steel companies in particular are building considerable additions and this is true in various lines of manufacture for which rolled steel is the raw material. There has been an exceptional demand for bars for reinforcing purposes and the turning of so much mild steel into war channels has increased the call for high carbon bars for reinforcing. In a number of cases bars rolled from rails have been accepted for work usually let under soft steel specifications. The fabricating works are having difficulty in getting full shipments under their contracts and in some cases are having to eke out by paying stiff prices for shapes from warehouse stocks. Whatever the number of building projects put aside on account of high cost of steel, such action has made no impression on prices. The tendency is still upward where early deliveries are involved, and from present indications it will be a good many months before high prices will cause any loosening up in the situation at structural mills.

The condition of the steel market is reflected in equipment. A number of mixer manufacturers have found it necessary to advance prices and undoubtedly other advances will follow. While a good proportion of mixer manufacturers state their ability to deliver promptly at the present time there is every reason to believe that late mixer buyers will have trouble in securing delivery.

League to Contest Septic Tank Royalty Claims

AN organization known as the National Septic Process Protective League was formed at Des Moines, Ia., Mar. 14, 1916. The object of the League is to defend all suits against its members for alleged infringement of septic tank patents. The Cameron Septic Tank Co., Chicago, claims to hold patents on which it is endeavoring to collect royalties from municipalities and others employing the septic process.

It is believed by the members of the League, backed by the opinion of competent counsel, that the Cameron patent has expired and that the claims of that company are excessive and unjust.

Membership in the League is unlimited and open to municipalities, companies, corporations, institutions and private individuals interested in sewage disposal. Assessment will be levied according to population served by the system involved, as follows:

Less than 2,000 population	$10.00
2,000 to 5,000 population	15.00
5,000 to 10,000 population	20.00
10,000 to 20,000 population	25.00
20,000 to 50,000 population	30.00
Over 50,000 population	35.00

The funds raised by these assessments will be used to engage competent counsel and an endeavor will be made to enforce a prompt decision of the matter in the highest courts.

As the claims of the Cameron company include not only what is known as the septic tank, but extend to those systems which reduce the solids by putrefaction, known as sedimentation or settling tanks, and also the Imhoff tanks, and as the royalty demanded is 2% per annum on original cost of complete plant and additions, the importance of a definite decision of these claims is readily seen.

Officers were elected as follows: H. M. Bracken,[1] Pres.; Elliott Kimberley, Vice-Pres.; C. F.

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[1] Secy. of the Minn. State Board of Health, Minneapolis

Pierce,[2] Secy. and Treas. The Executive Committee consists of C. A. Haskins, Kans.; Paul Hanson, Ill.; Lafayette Higgins, Ia.; A. Marston, Ia., acting with the officers of the League. A Board of Directors consisting of two members from the states of Iowa, Kansas, Ohio, Illinois, California and Minnesota was also chosen and the secretary was instructed to complete the list of directors for other states.

Government Aid to Industry

THE National Physical Laboratory, in London, through its engineering department, is doing great work in the way of research in connection with the strength of cement and other building materials. Strange to say, the great work of this important laboratory does not seem to be thoroughly appreciated in England and recently considerable effort has been made to obtain an enlargement of the appropriation for the work in question. In commenting upon the value of the research work, one of the English engineering papers, referring to the application made to the Government on behalf of the National Physical Laboratory, says that the "Germans have possibly realized more fully than any other nation the necessity of assisting their industries by scientific experiments, and they rightly consider that no important improvements in any industrial process can be expected until after exhaustive scientific research has been undertaken. America has also been advanced in this respect and the Bureau of Standards at Washington receives an annual grant of $500,000 from the Government and again in France they are advanced far beyond Great Britain as regards research work." The writer is entirely correct in his statement and were it not for the fact that the cement industry in England is a compact organization, practically all under one head, the reputation of English cement would not have progressed as it has in late years. It was due to the scientific research and the wonderful work of such men as Michaelis, Dyckerhoff, Schott and others that the art of Portland cement manufacture made such remarkable progress in Germany, and the development and proper support of the National Physical Laboratory in England will have a two-fold effect of improving the condition of the cement industry and widening the field of concrete development.

Cheap Block

EVERY little while a strong argument develops in favor of much more rigid building regulations in regard to the manufacture and use of concrete block. It very frequently happens that loose regulations actually work a hardship upon concrete block manufacturers. Recently, a manufacturer who has the upbuilding of the industry strongly at heart made the statement that the curse of the block business is the speculative builder who puts up cheap houses to sell quickly, with no special interest in the quality and lasting value of the job. He calls on the block men and wants block for a foundation wall, and frequently expresses himself as not caring a hoot about the quality of the product—he wants the cheapest unit that is made with which a wall can be laid up. This sort of business develops ruinous competition which so lowers the quality of products in a community as to injure the industry in its future growth, because it is inevitable that poor jobs built up with the cheapest units that can be made will ultimately come to haunt the manufacturer who is trying to sell his quality products in the face of early failure.

Concrete Aggregates

THE third article in the series on "Concrete Aggregates" by William M. Kinney and Duff A. Abrams, does not appear in this issue, as announced. The lapse is very much regretted. Extensive revision of the manuscript by the authors, so that it may include data recently accumulated in extensive tests, makes the delay unavoidable, and it is to be hoped that readers will be patient with this month's omission, in view of the additional value of the article which postponement of publication makes it possible to put into it.

Concrete Roofing Tile

THE manufacturer of concrete roofing tile has not been an important factor in the concrete field and it was therefore a very interesting development to find at the recent show in Chicago that this particular unit in the concrete field shows strong evidence of "coming back." There is good reason to believe that it is re-establishing itself on a new basis. The idea now is not to sell a concrete roofing tile machine to a small operator but to sell a dozen machines or more for an extensive plant, a plant which will be operated day in and day out the year through with modern manufacturing methods. Large continuous output is necessary for any signal success with such small units and the manufacturing end of the business must be coupled up to efficient sales methods.

Water in the Mixer

THE time of introducing water into the mixer received considerable discussion by visitors at mixer exhibits. Present practice seems to be to introduce at least a part of the water before the cement and aggregates are delivered to the drum, care being taken to have the cement covered by the aggregate in the skip.

This method results in a quicker mix and where this procedure is followed the mixer drum will be found to keep itself clean, so that in some cases better mixing will result.

Various tests show the adhesive strength of concrete to steel rods to be from 700 lbs. per sq. in. down; 250 lbs. is about the average and should be used with a safety factor.

Do not fail to wet old concrete thoroughly before attempting to join new work to it.

Concrete

STATEMENT OF OWNERSHIP, MANAGEMENT, ETC.

Concrete

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F. F. Lincoln, 71 W. 71st St., N. Y. C.
Roy Marshall, 27 La Salle Gardens North, Detroit.
Allen V. Brett, Cleveland, Ohio.

There are no bonds, mortgages or other securities issued..

(Signed) Walter C. Boynton,
General Manager.

Sworn to and subscribed before me, a Notary Public in and for the County of Wayne, State of Michigan, this thirty-first day of March, A. D. 1916.

IONE MICHAEL.
Notary Public.
(My commission expires Mar. 19, 1919)

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[2] Marshalltown, Ia.

The Construction of an Open Air Concrete Swimming Pool in the Canadian Rockies

By William Wren Hay

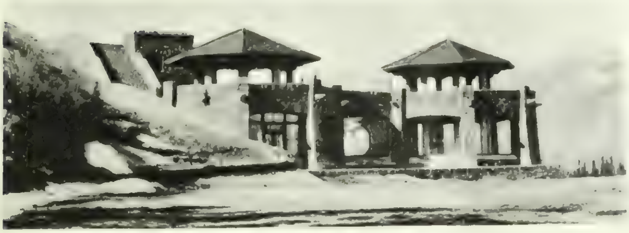

Fig. 1—View of End of Pool Structure

The first unit of what will ultimately be one of the largest open air swimming pools in North America has been put into operation by the National Parks Commission of the Dominion of Canada at Banff Springs, one of the mountain resorts of the Canadian Rockies in the province of Alberta. The pool and the dressing rooms combine several unique features of design and construction, and are located on the side of Sulphur Mountain, 4,575′ above sea level, overlooking the Bow River Valley. For some years bathing has been conducted in a natural basin in the hillside, formed by the overflow of one of the many hot sulphur springs of the vicinity, a feature of the pool being the cave with its natural opening only into the basin, the whole being well known as the "Cave and Basin." The new development contemplates eventually covering over the Basin by an open belvedere 30′ in diam., forming the central features of two flanking outdoor swimming pools terminated with double belvederes as shown by the illustrations.

The pool which is described has a length of 150′, and is 35′ wide, built on a bench excavated in the mountain side. The bath house containing the dressing rooms lies between the swimming pool and the high bank, and acts as a retaining wall. At one end there are two belvederes 37′ in diameter, in use as rest room and office. The entire surrounding area is saturated with sulphur water, and the problem of retaining the excavated bench was complicated by the nature of the foundations for the retaining wall.

The bath house is designed as a hollow retaining structure, the pressures on the rear wall in contact with the saturated earth being partially transferred to the front of the structure by means of six reinforced concrete arches (see Fig. 2). The entire structure is founded on 300 piles, driven in clusters. Excavation was carried out in the winter time, as the moisture in the bank would freeze upon exposure to maintain its position, yet the interior temperatures from the hot sulphur water would not permit the freezing action to extend far enough to make the cost of removal prohibitive. When thoroughly dry, this earth became partially solidified in the vertical face, so that no difficulty was experienced during actual construction. However, a bed of quicksand just below the foundations prevented any increase in the loading of the piling. Approximately 1,700 cu. yds. of semi-rock were removed.

RETAINING WALL CONSTRUCTION

The principal feature of the structural design is the method of retaining the rear wall of earth against which the structure is set. This wall has a total height of 40′, and consists of two reinforced concrete slabs, the upper half being designed as a vertical slab carried by the roof beams at the top and by a horizontal beam at the bottom; the lower half carried as a horizontal slab between columns which support the upper construction. The beams at the middle of the wall were then designed for bending moments in a horizontal plane to carry the reaction of the wall pressures, and in a vertical plane to carry the weight of the slab and the beam. There are six arch rings springing from the columns in this wall, each 36″ wide, and 24″ thick at the crown, reinforced with six 1¼-in. sq. rods. These arches are carried into the foundations at the front of the bath house by buttressed piers supported on pile clusters. Over the arches there are 12-in. walls, supporting the skeleton beams for the prism lights in the roof.

In order to mask the front wall

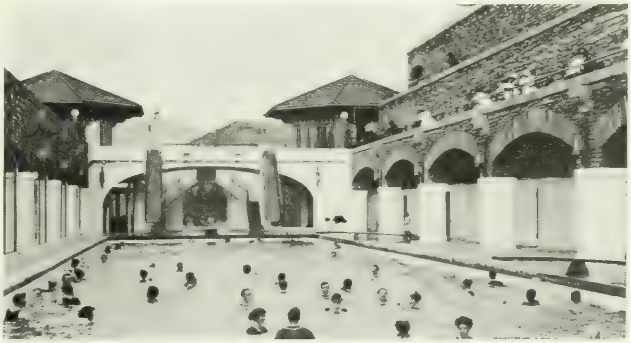

Fig. 2 Swimming Pool, Showing Terraced Retaining Wall

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¹Jr. Can. Soc. C. E., Ft. Sam Houston, Tex.

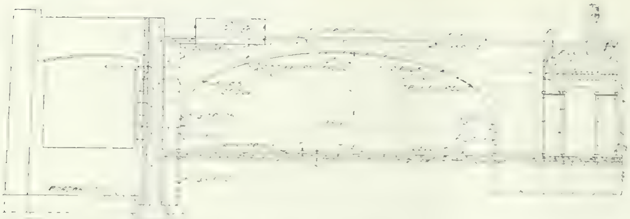

FIG. 3—DIAGRAM, SHOWING ARRANGEMENT OF POOLS

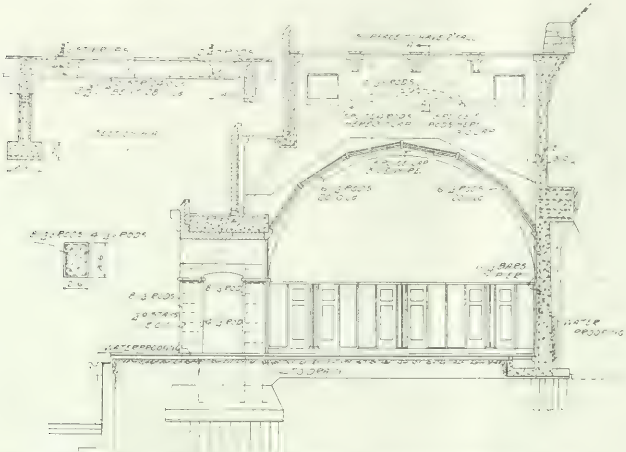

FIG. 4—SECTION THROUGH TERRACE, SHOWING METHOD OF RETAINING BANK

construction, galleries are formed over the buttress piers and over the haunches of the arches, and these, with the roof, are used by spectators. Fig. 4. The roof is flat and lights the interior of the bath house through prism lights and diffuser sash below. Access to the roof and the galleries is had by means of an outside stairway formed on the ground at the end of the belvederes.

The pool has a minimum depth of 3′ at one end, and a maximum depth of 8′ at the other, and is formed by light reinforced concrete retaining walls around the sides, with concrete floor on earth. The concrete walls and floor are waterproofed by a membrane consisting of 5-ply felt and tar, and the entire pool was then lined with white enameled brick, with terra cotta scum trough throughout the perimeter. Outside the pool there is an arcade, consisting of seven concrete arches, filled with plate glass windows, acting as a wind shield for the swimming pool. At the end there is an elliptical arch connecting the two belvederes, upon which are two diving blocks and chutes, reached by a free winding stair from the pool level. The bath house is 137′ long, 27′ wide, and contains 132 individual dressing boxes, together with the necessary toilets. The enclosed areas are heated by steam, and lighted by electricity.

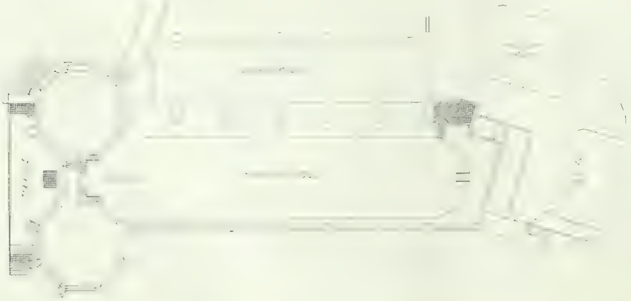

FIG. 5—DETAIL OF ARCH AT END OF POOL

SURFACE TREATMENT

Aside from the structural design, the principal interest lies in the treatment of the exterior surfaces. The wall surfaces are veneered with thin blue limestone stretchers backed with concrete, and the piers and details are all smooth concrete surfaces. The limestone is quarried within sight of the swimming pool, and readily split into pieces 2″ to 5″ thick, which, when laid up with deep raked joints ¾″ wide, gave a excellent texture to the walls. The stone work was laid in dry mortar against latticed forms which assured true vertical surfaces, and was then backed with concrete in the usual way, the stones forming one side of the mold and ordinary wooden forms the other. Cast concrete ornament was used on this work, the surfaces being brushed with cement mortar and carpet-floated after erection. The use of red Welsh quarry tile with cement border for all exterior floors added a touch of warm color to the otherwise cold concrete and limestone.

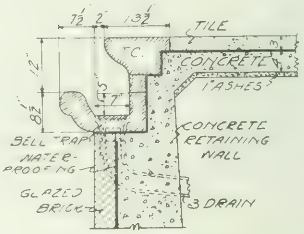

FIG. 6—DETAIL OF SCUM TROUGH

There are about 750 cu. yds. of mass concrete in the structure, and 1,350 cu. yds. of reinforced concrete. The concrete work was very expensive, both on account of the large area of the structure, and also because of its isolated location. The matter of hauling was a large item, as all transportation from the railroad, about two miles, had to be done by teams. Gravel was taken from the Bow River in front of the structure and was the only cheap material entering into the construction. The small quantities involved made cheap buying difficult, so that most materials were freighted from Calgary or Winnipeg, the nearest local markets.

Cement was purchased from the Canada Cement Co., Ltd., at its Exshaw Mill near Banff, but cost about $3.50 per bbl. in the forms. Lumber for forms was also expensive, as most of it could be used but twice at the outside. Plant for concrete work was doubly expensive, due to freight and teaming both ways from Calgary. The wage schedule on Government work increased the cost over the usual contractors' estimates, so that the total cost for a cu. yd. of concrete in one of the arches was estimated at close to $30, including the reinforcing steel.

The cost of the pile foundations, including excavation, was about $10,000; the cost of the contract work, performed by Worswick Bros., Winnipeg, was above $100,000. The architect was W. S. Painter, Banff, formerly architect for the C. P. R.

Effect of Salt Water on Brick, Mortar and Concrete

The effect of salt water upon concrete is ancient history and many have been the investigations conducted along this line. A queer case of parallelism in this field is told in the *Annali Chimia Applicata* A warehouse in Turin, Italy, had been used for more than 40 years for the pickling of anchovies in brine and for the storage of barrels of preserved fish. Recently one of the vaults collapsed. Upon investigation the collapse was found to be due to the effect of the prolonged infiltration of the brine on the mortar and brickwork. The affected mortar and brickwork were found to be soft, and upon chemical investigation were found to contain considerable quantities of chlorides and organic matter, viz., up to 5.25% (calculated as sodium chloride) and 8.36%, respectively, referred to the dry material. This is an interesting fact, showing the analogy in the behavior of concrete in almost all conditions when exposed to the effects of salt water. The wave action which, according to many authors, is responsible for the disintegration of concrete in salt water, does not appear to have been present in the case above described and it is possibly due to this fact that the disintegration occurred after a much longer period than where the mortar, improperly prepared, is exposed to the continued action of sea water reinforced by wave power.

The concrete silo is finding a new application as an economical storage unit for sand and gravel, coal, cinders and other bulk material.

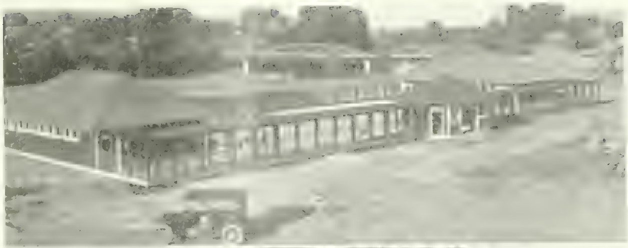

Fig. 1. General View of Shelters, Pool and Bath Houses

Fig. 2. Section at Deep End of Pool

Construction of a Concrete Swimming Pool at Pendleton, Ore.

By L. R. W. Allison[1]

A recently constructed concrete natatorium at Pendleton, Ore., is an outdoor structure of reinforced concrete with frame bath houses and shelters.

The pool is 50′ x 100′, with a depth varying from 2′ 6″ to 8′ 6″. The floor is reinforced with 3/8-in. steel rods, 6″ o. c. in both directions. The wall reinforcing is clearly indicated in Fig. 2.

The heavy reinforcement was necessitated by the pervious nature of the soil, which in excavation and construction work caused difficulty and interference by seepage water from the Umatilla river, a short distance from the north side of the pool. In periods of freshet the river level is higher than the pool, making reinforcement against outside pressure necessary. Flooding is prevented by a levee.

The edge of the pool is finished with a terra cotta life rail and scum trough, backed with concrete. The walls are plastered 1/2″ thick with 1:2 cement mortar. The floor was given a 3/4-in. finish coat. White cement and sand can be employed to advantage for this purpose, making an inexpensive but sanitary and attractive finish.

The water supply is obtained from the city system arranged to fill the basin from either the pressure mains or the overflow from the water storage reservoirs. The latter, affording great economy, provides sufficient service except in times of maximum consumption. Special consideration is now being given to warming the water to a proper bathing temperature at all times, extending the months of use.

The natatorium buildings (Fig. 1) consist of a central entrance shelter and two bath-houses, one at either end of the pool, provided with 208 lockers and toilet rooms. Plans for extension include a covered grandstand for spectators and a shallow wading pool for younger children.

COSTS

This structure represents an investment of $10,700, about 10% in excess of the original estimate, due

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[1] Newark, N. J.

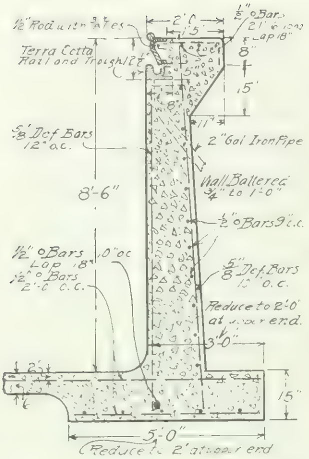
½" Rod with 3/4" ties
Terra Cotta Rail and Trough 12½"
2'0"
1'5"
½" o Bar 21'6" long Lap 18"
8"
1'5"
8"
11"
5/8" Def Bars 12" o.c.
2" Gal Iron Pipe
8'-6"
Wall Battered ¾" to 1'-0"
½" o Bars 9" c.c.
½" o Bars Lap 18" 1'0" oc
½" o Bars 2'-0" c.c.
5/8" Def Bars 1'0" o.c.
Reduce to 2'-0" at upper end.
3'-0"
2½"
6"
15"
5'-0"
(Reduce to 2' at upper end

Fig. 2—Section at Deep End of Pool

to the trouble encountered with water seepage. The actual costs of the work are:

Engineering	$ 125.00
Superintendence	626.00
Initial contract for pool and buildings	7,358.00
Extras to contractors	42.85
Labor with teams—excavating, backfilling, pumping, grading, etc.	415.60
Labor—for pool, drain, supply pipe, pressure pipe, etc.	889.85
Life rail and scum trough, terra cotta	480.00
Cement, sand and lumber	50.15
Sewer pipe	177.15
Pipe, valves, hardware, etc.	188.50
Miscellaneous labor and supplies	252.44
Dravage	8.75
Liability insurance	37.41
Stationery, printing, advertising for bids	37.35
Office supplies, postage, etc.	10.88
Total	$10,699.93

HOW THE POOL WAS FINANCED

The building fund, with the exception of $2,000 appropriated by the city, was obtained by popular subscription through the efforts of Pendleton Commercial Assn., the amounts subscribed ranging from 25 cts. to $100. Upon completion, the natatorium was turned over to the city as a municipal structure, practically free of debt. To make the enterprice self-supporting, a charge of 10 cts. for bathing privilege is made on two days of the week, while at all other times the use is free. The revenue from this source has proved ample to cover the cost of operation, including two attendants and other minor expenses. The pool is located in Roundup Park. This tract, the scene of the famous Pendleton roundup, was deeded to the city by the Roundup Assn. for a public playground, and all surplus revenue derived from the annual show is devoted to the permanent improvement of the property.

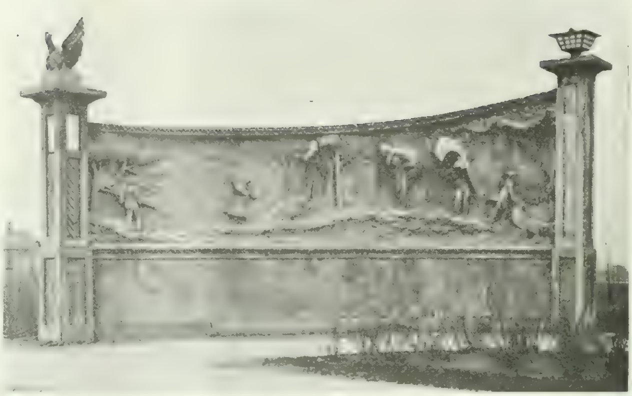

Fig. 1—One Side of Entrance, Portage Park, Chicago, Modeled in Neat Cement Paste

Concrete Improvements in Portage Park, Chicago

Chicago parks in general have liberally used concrete to make various permanent park improvements. For instance, several of them use concrete posts where fencing is necessary. All have concrete drinking fountains and walks; and the concrete work is largely, if not entirely, performed by employes of the Park Department.

One of the newer Chicago parks recently developed in the northwest section of the city is known as Portage Park. Here also concrete has been used extensively, and in one instance in a very novel way, namely, in modeling in relief panels intended to commemorate or typify an actual old-time portage, from the North Branch to the Des Plaines River, since the site of Portage Park is in the vicinity of a spot at which in the early days a portage was made necessary. The modeling is on panels that form an entranceway at one side of the park, and is remarkable in that the work was performed by an old German artist, Herman Grass, who used a neat cement paste as his medium, building up the sculptured figures life size on ¼-in. wire mesh. The wire is bent as nearly as possible to the shape of the object before modeling is done. The work is supported by a timber frame covered with the cement mixture.

The pergola and the lily pond are of concrete, as are the lighting standards in the park, these being of

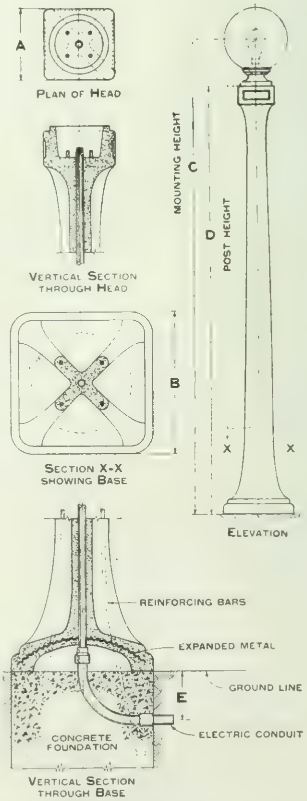

Fig. 3—Details of Lighting Standard

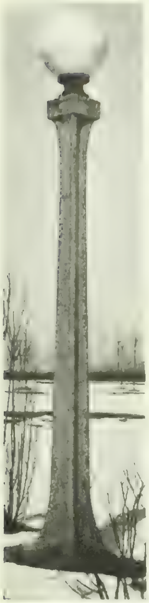

Fig. 3 Concrete Lighting Standard

the type known as the Star[1] lamp post, on account of the cross-section. Construction is of concrete, in which the aggregate throughout consists of mica-spar.[2] These posts combine minimum weight and maximum strength, and are made from a wet mixture compacted by vibrating the mold while depositing. They are molded in one piece and may be easily erected by two men without the use of a derrick or other elevating device. Curing is by natural processes. As soon as it is possible to remove the mold the surface is washed with plain water, thus removing the cement from the surfaces of the spar particles and producing a finish of rare beauty. Accompanying illustrations show one of the finished posts and details of construction.

In another illustration two monolithic posts with lighting standards on top are shown. These serve to define another entrance to the park. A concrete drinking fountain appears in the foreground of this view. This fountain was made by park employees after a design embodying the principles of the lighting standards, being constructed of spar aggregate throughout and finished so as to have the same surface texture.

[1] Made by Chicago Concrete Post Co., Chicago

[2] Crown Point Spar Co., N. Y. C.

Limestone aggregate should not be used for sewers or other construction subject to the action of running soft water. Samples of limestone kept 6 mos. in running soft water have been found to lose weight at the rate of 6⁸⁄₁₀% to 18¹⁄₁₀% per yr.

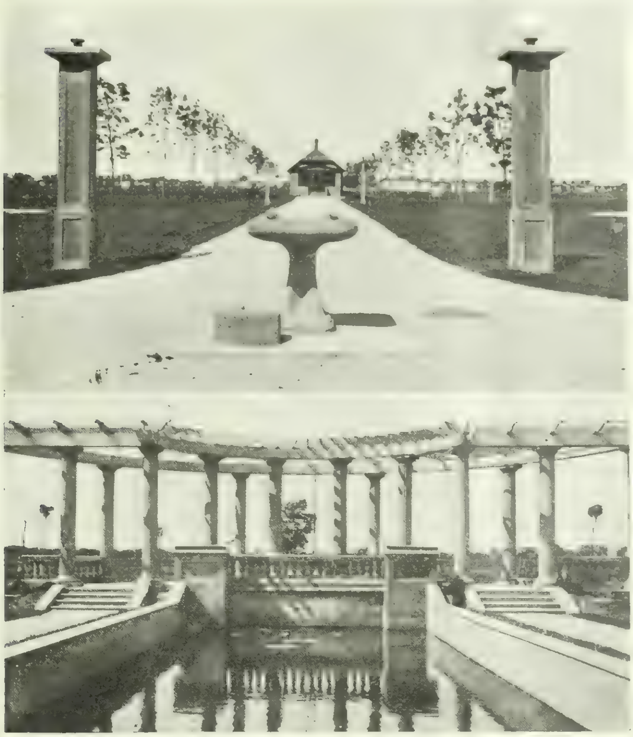

Fig. 4—Pergola, Pool, Drinking Fountain and Entrance Pillars of Concrete, Portage Park

Bond of Steel in Reinforced Concrete

In a recent number of the *Iowa Engineer*, C. A. Baughman[1] cites an instance to show that more attention should be paid to working concrete around reinforcing in order to secure proper bond at the bottom of the bars. He says:

In cutting a large number of small holes in the bottom of a concrete bridge slab recently, to expose the reinforcing bars for the purpose of taking measurements thereon, considerable side light was thrown on the matter of getting good bond. The slab was reinforced with ¾-in. corrugated bars on about 6-in. centers. The concrete below the bars was about 1½″ thick. So far as is known, the concrete was mixed as thoroughly as is usual on such a job, and placed as carefully. In fact, it may be taken as an illustration of ordinary practice.

Use was made of various shaped cold chisels in cutting the holes for measurements, and in general the concrete adhered to the bars so that scraping was required to clean them. On numerous occasions, however, the last of the concrete would fly from in front of the chisel and the rod would be left perfectly clean. A steel "scriber" was used in marking and in working the holes. This instrument had one end bent at right angles ½″. It was noticed that sometimes when the concrete came off the rod so readily, there appeared to have been a cavity under the rod. The bent end of the scriber was brought into use and many times could be run the full half-inch along the rod, showing that many times the concrete (or more strictly, perhaps, mortar) fails to flow absolutely to place under the rods. This difficulty will necessarily be greater with large reinforcing members, coarse aggregate, close spacing, dry mixtures, etc., but cannot fail to be a cause of lessening of bond in any reinforced concrete work which is not put in very carefully indeed.

[1] Instructor in C. E., Iowa State College

It is interesting in connection with the highway bridge work discussed at the Am. Concrete Inst. meeting at Chicago, to find that the Concrete Inst. in England has a committee consisting of representatives of the Institute, the Institution of Municipal and County Engrs. and the Institution of Municipal Engrs., which recently made a draft report on the subject.

Concrete Lighting Standard Made By Centrifugal Process

By L. R. W. Allison[1]

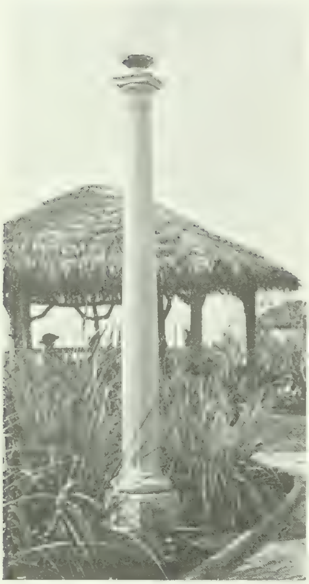

Fig. 1 Lighting Standard, Made by Centrifugal Process

The superiority of reinforced concrete lighting standards over various forms of metal posts, such as bronze, wrought and cast iron, copper covered or pressed steel, has become generally recognized. Not only is the initial cost of the concrete post considerably less, but the expense of maintenance and upkeep represents an almost negligible item, no painting being required to preserve the appearance.

An improved type of reinforced concrete post for street lighting is now being manufactured in southern California and it is used in many municipalities in that vicinity. This standard, shown in Fig. 1, is made by a centrifugal process of molding which offers some interesting features of operation. The centrifugal method of formation indicates, both in theory and in practice, a logical and effectual means of production, at the same time showing reduced cost factors that tend to enhance the extensive employment of these standards for all practical and economical purposes.

The fundamental principle involved in centrifugal concrete manufacture is that of effecting proper compression by centrifugal action. As is evident, in revolving a wet mix by this process the area of greatest compression is at the point of greatest radius. This affords the desired density in sections where it is most needed, resulting in a product, with cored center, of great structural strength and stability.

As indicated in the sectional diagrams of angular and circular concrete structures, Fig. 2, the hardest portion will be at the outside and the thickness of wall can be governed by the amount of material used. This placement of the heavier and the finer particles in concrete by centrifugal action, forming the densest mass at the outside, affords a consistent distribution in the proper proportions of the respective ingredients.

These standards are composed of a 1:3 mixture, consisting of 1 part Portland cement and 3 parts clean washed sand and gravel. This aggregate is mixed with sufficient water to permit pouring into forms which, of wood or metal as required, are of the desired outline and dimensions, and made in two or more parts as the exterior design may necessitate. The steel reinforcement is built up and placed in the mold, supported from the wall on a dead center.

When filled, the forms are locked in a machine and revolved at a proper speed to compact the mixture, sustaining the wet concrete against the walls. The exact rotating speed is dependent upon the diameter of the post. In this operation all voids are filled and the resultant product has a hard, smooth surface that cannot be obtained by ordinary tamping. The preliminary set is obtained in about 30 min. and the mold is withdrawn and allowed to stand for 24 hrs. before removal. After this time, the formed structure is capable of being handled without danger of injury to the surface; an additional curing in the open air, keeping the product thoroughly moistened, completes the process of manufacture.

A sectional view of a typical post is shown in Fig. 3. The shaft is reinforced with four ¼-in. square twisted steel rods, equally spaced around the circumference and ¾" from the outside wall. The rods are wired and held in place with No. 14 wire hoops. The standards have a hollow core, varying slightly for different types of design, but not less than 3", extending from end to end. This core is concentric with the outside surface of the post.

The base, of square or octagonal pattern, as desired, and capital are cast separately under the centrifugal

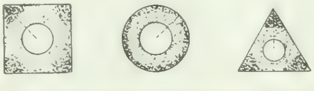

Fig. 2 Sectional Diagrams of Three Standards

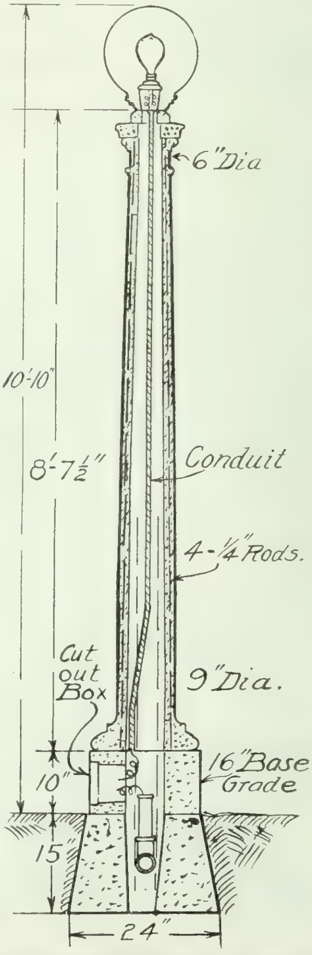

Fig. 3 Detail of Lighting Standard

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[1] Newark, N. J.

process. The former is provided with a 4 in. x 4 in. x 6 in. cut out box with concrete cover. Foundations for the standards are cast in place, reinforced with ⅜-in. twisted steel rods 5′ long in center, and the post securely anchored to this footing.

The hollow core of the shaft is arranged for the electric conduit, which extends from the cut-out box to the lighting fixture at the top. The conduits enter the sides, as indicated in the drawing, and are bent up to go into the cut-out box in the base of the standard. After the conduit is installed, the core is filled with cement grout and a cast brass shade holder screwed in position on the end of the conduit.

In finished surface these standards resemble cut or polished stone, which has resulted in the trade name of Marbelite. The post being hollow, is accordingly lighter than a solid column, and at the same time, is considerably stronger. Tests for absorption show that the surface of these posts take up less than one-half the moisture absorbed by well tamped concrete of the same mixture in a like period of time.

While this method of concrete manufacture is suitable for other products of post or column type, it has become particularly applicable in making reinforced concrete electroliers, and extensive activity is being given this line of operation. Classic designs modeled after Greek and Roman architecture are being adopted for various column types, supplemented by bases and capitals of harmonizing pattern.

Many cities and towns in southern California are now employing these lighting standards along important thoroughfares, such as Los Angeles, Santa Monica, Hermosa Beach, Manhattan Beach, Newport and Monterey, while other communities have arranged for installation in the immediate future.

Waterproofing Concrete Surfaces[1]

Some interesting experiences in the waterproofing of concrete surfaces are give in *Reclamation Record*, by J. L. Lytel, project manager of the Strawberry Valley project, Utah. The storage works and tunnel of the Strawberry Valley project are located in the Wasatch Mountains at an elevation of 7,500′. The variation of temperature in this vicinity is very wide and the climate in winter is very severe, temperatures as low as 50° F. below zero being recorded, while the snowfall ranges from 10″ to 24′ in depth.

The extreme cold, with alternate thawing and freezing of water in the pores of the exposed faces of the concrete, was found to have a very destructive effect on these concrete structures and the waterproofing of the surfaces was decided upon as a preventative against their continued disintegration.

It was decided to treat the vertical surfaces with alum and soap solutions and the horizontal surfaces with paraffin. The alum solution was made by dissolving 2 oz. of alum $KAl(SO_4)_2$ in 1 gal. of hot water. The soap solution consisted of ¾ lb. of castile soap dissolved in 1 gal. of hot water. The paraffin was boiled to drive off water as the presence of water rendered it hard to apply. Ordinary commercial products were used.

The surface to be treated with paraffin was first thoroughly dried and cleaned of loose concrete, dirt and other foreign material. The heated paraffin was then applied with a paint brush and forced into the pores by the heat of a blow torch on the surface. Only one coat of paraffin was applied as the concrete would not absorb more.

The surface to be treated with soap and alum was cleaned as stated and the alum solution was applied at a temperature of 100° F. with a moderately stiff brush, and was then worked in with a stiff horse brush. While the surface was still moist from this treatment the hot soap solution was applied in the same manner, one treatment of each solution constituting a coat. If other coats were considered necessary, they were applied in like manner after the preceding coat had been allowed to stand 24 hrs. or more.

Twelve structures were given this treatment, the surface area covered being approximately 28,000 sq. ft. Four thousand sq. ft. were treated with paraffin at the rate of 1 pound for 11¾ sq. ft and the remainder with soap and alum. One gal. of alum solution and ½ gal gal. of soap solution covered 50 sq. ft. with two coats. Two coats of alum and soap were applied at an average cost of $0.75 per 100 sq. ft., and the cost varied from $0.41 minimum to $1.28 maximum. The cost of one coat of paraffin varied from $1.70 to $3.78 per 100 sq. ft., and averaged $2.11, this cost including everything except general expense. The work was done by two men receiving $75 and $80 per mo., while brushes cost $6.06, castile soap $0.12½ per lb., alum, $0.18 per lb., and crude paraffin $4.80 per cwt.

The results obtained by this style of waterproofing are considered very satisfactory. The structures that were repaired and treated have passed through two severe winters and no further disintegration of the concrete has taken place in any part.

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[1] By A. M. Wolf, in *Railway Engineering and Maintenance of Way*

Overhead Charges to be Considered in Making Up a Bid

1. Expense of making up the estimate and bid.
2. Cost of surety bond.
3. Cost of liability insurance, workmen's and public.
4. Cost of plant and equipment.
5. Moving plant.
6. Maintenance of equipment, including cost of repairs and supplies.
7. Tools lost, broken and stolen.
8. Wasted material.
9. Demurrage.
10. Losses due to weather conditions and damages by the elements.
11. Payroll and expense of outfit in rainy weather.
12. Water charges.
13. Damages to private property.
14. Cost of inspection of materials.
15. Lost and damaged cement bags.
16. Being a good fellow.

There have been omitted some two or three items which apply particularly to highway contracts, but the list is nearly applicable to any work. Although that last item might be inferred to include a sum to cover all forgotten contingencies, we would add to the list for big construction jobs:

17. Depreciation of plant.
18. Engineering staff.
19. Equipment and maintenance of field offices.
20. Fees for various local permits, explosives, magazines, etc.
21. Cost of electric light and power.
22. Interest on borrowed capital.
23. Loss on extra work provided for on "cost plus 10% basis, since there are many small charges that should be allowed that are not.
24. Premiums on accident bonds, and, last but not least,
25. Annual retainer to counsel.

We were going to add another item covering the loss sustained due to minor changes in plans, but, on second thought, maybe that is included in the item of "being a good fellow."—*The Contractor's Atlas.*[1]

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[1] Atlas Portland Cement Co.

Forms For Concrete Work—Some Factors to be Considered in Their Design

By R. A. Sherwin[2]

Economical design and construction of form work often determine whether or not a job will yield a profit. It is significant that in the face of rising labor and lumber markets, the unit cost of concrete forms has decreased. Some of the factors to be considered in the design of forms and the proper treatment of form design in the hands of the designer, in the drafting room and on the job, are the subjects of a paper of more than ordinary value to both contractor and engineer which is presented in part in the following pages.

Numerous cost analyses show that labor on forms averages about one-third the labor cost of the building, the labor cost being about 25% of the total cost and that lumber for form work costs about 1/10 of the total material, including sub-contracts.

Issue is taken with an article published in CONCRETE[3] which says, "too much stress cannot be placed upon the importance of having an ample number of shores under the forms, which should be regulated by the judgment of the foreman carpenter." It is believed that in all cases drawings should be made in the office of the contractor, showing the foreman just what support is needed. Issue is also taken with the following statement in CONCRETE:[4] "Plans and details for forms are required to be furnished by the contractor and should be submitted to the engineer for his approval before starting the work, but such approval should not release the contractor from responsibility," etc.

Mr. Sherwin believes that this is incorrect and that the engineer should be interested in results only, and that since the contractor is responsible for the work, he should design the forms.

GENERAL PROBLEM

Economical forms must be designed as light and with as few sticks as possible to give the necessary strength and stiffness. We must remember on the one hand that human lives and the cost of failure, both in money and reputation, are dependent upon the design, and on the other hand that form work is a temporary structure fully loaded for a short time only and that a low factor of safety is therefore allowable.

The main question, then, is one of strength with enough stiffness to prevent any appreciable sags in the finished concrete. Any slight deflection that might occur in the timbers themselves is taken care of in the camber always given horizontal members in erection.

The strength of the floor timbers should be designated for the full live and dead load, but any serious deflection will be caused only by the dead weight of the wet concrete. The full live and dead load can act together for a very short space of time only. One place where deflection should be carefully guarded against is at the window head. At this point a slight deflection will cause much trouble and expense in setting the sash.

The principal cause of settlement of form work is crushing of the soft spruce or pine lumber perpendicular to the grain in the girt over the post, and also in the adjustment of the wedges under the posts as the full load is applied. An average safe value to use in form design for this crushing stress, as determined by numerous tests, is 400 lbs. per sq. in for spruce. Considering this stress, a 4-in. x 4-in. spruce post under a 4-in. wide girt is good for 6,400 lbs.

The trouble due to wedges can be almost entirely eliminated by using large hardwood wedges. If the posts are cut square at the ends to give an even bearing and heavy wedges used to bring the posts to grade, no settlement will occur.

Posts are usually placed on a plank sill. When these sills are laid on the ground great care is needed in order to avoid settlement because of deflection in the plank when a hollow place comes under the post. This often occurs when sills are placed on frozen ground, and salamanders thaw out portions of the surface and cause soft places under the sills. When light sills are placed on a rough concrete floor deflection is liable to occur unless care is taken to give the sills an even bearing.

For these reasons I believe that limiting the floor timbers to very small deflections and at the same time using high loads on the posts is not consistent, and surely not economical.

DESIGN

The first thing to be done in preparing a form design for a concrete structure is to make a careful analysis of the plans submitted by the engineer. This should be done as soon as the preliminary plans are available, for many details which seriously affect the progress and cost of the forms may be brought to the engineer's attention and changes made for the benefit of the owner. These points are often overlooked by the engineer, who does not always look at the structure from the construction point of view.

Chief among these points is that of story heights. It is desirable that these heights be kept uniform throughout the building so that the column forms can be re-used from story to story without either cutting off or splicing. It is better to have the high stories at the bottom, as cutting off forms is much cheaper than splicing them.

Another important point is construction joints. These should be planned and reinforcement detailed so that the forms can be erected in the simplest possible manner. These joints should, of course, come at a natural stop for a day's work and be located so that they will least affect the appearance of the finished structure. The position and detail of any expansion joints should be determined early, as they will affect the form design and probably require special study.

An example of a detail to be considered in connection with the question of joints is the important one of making the dowels for the column rods long enough so that the necessary lap will come above the point where the column forms will actually start. It is not uncommon, for example, to find a wall beam, which comes above the slab, detailed so that it must be cast with the floor, but at the same time to find the lap

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[1] Abstract of Paper before Am. Concrete Institute, Feb., 1916

[2] Res. Engr., Aberthaw Const. Co., New Haven, Conn.

[3] By Jerome Cochran, June, 1915, p. 288

[4] By Jerome Cochran, Mar., 1915, p. 142

for the column rods shown above the top of the slab instead of above the top of the wall beam, as it should be.

It is economical to cast a curtain wall beam, used sometimes in mushroom construction, as a later operation. The forms can be made and erected more cheaply. This can easily be arranged by providing pipe sleeves through the column to take the negative rods and a slot in the column as a seat for the beam.

The kind of windows must be decided upon at once so that the necessary groove strip can be scheduled and attached to the column sides and beam bottoms at the "making-up" benches.

The floor finish will affect the form design. Questions as to the thickness of wood floor, or if granolithic, whether it is to be placed with the slab or as a separate operation, must be decided before the form design can proceed.

It is usual in the writer's work that excavation for the building begins at the same time the plans are started, or when the latter are in a very preliminary state. It is necessary, then, for the man in charge of the form design to be familiar with the structural design so that points such as have been noted may be settled, the lumber bought and the forms made up by the time the excavation is completed. When a complete set of plans are available the problem is easier.

The next step in the design is the preparation, by the cost department, of a progress diagram similar to Fig. 1. A description of the method of making the diagram is not within the scope of this paper. The limiting factor, however, is usually the date when the owner wishes the building turned over to him as part of his equipment. This diagram gives the dates on which the various floors must be completely formed in order that there will be time for the necessary "follow-up" work. These dates will determine how many floors of new forms are necessary and when the design must be complete in order to allow sufficient time for making-up and erecting. The number of men necessary to turn out the work in the drafting room in this time can also be estimated.

With this preliminary information at hand, a conference is now held between the man in charge of the form design and the job and traveling superintendents. The latter is constantly in touch with the lumber market and is able to tell when the design must be governed by any unusual conditions. The sizes and lengths of lumber stocked in different localities vary considerably, and it is always desirable to make up the design of sizes that can be obtained at the lowest cost, in the required time and in the necessary quantity. Delays because of non-delivery of the lumber are costly.

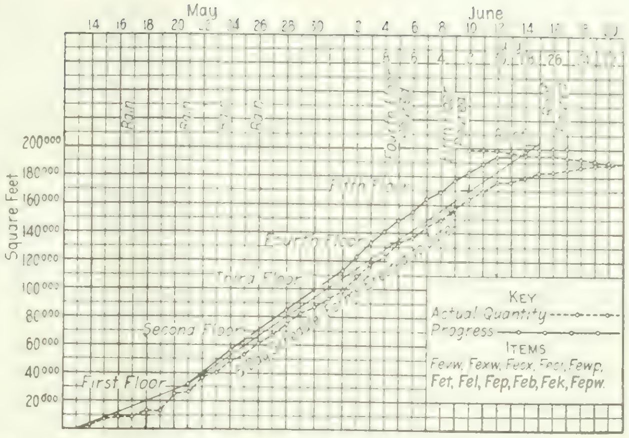


Fig. 1. A Typical Progress Curve for Reinforced Concrete Buildings

Another point to be settled is the part of the job at which construction will begin. This matter is usually governed by field conditions and has to be decided by the superintendent in charge after his study at the site. The movement of the forms throughout the job is dependent upon where erection is to begin and, therefore, must be known early.

The size, kind and location of the concrete plant have some effect upon the form design and should be discussed at this conference. The capacity of the plant will determine a day's concrete work and will affect the location of construction joints. The speed of the work is also sometimes dependent upon the concrete plant.

At this time the general scheme of the form design can be discussed and any suggestions from the experience of the superintendents may be incorporated. If the job superintendent and his carpenter foreman are in sympathy with the scheme a better job will result from this team work.

In calculating the sizes of form members, we do not use a standard set of loadings, formulas, etc., for all cases, but treat each one separately, according to conditions. In general we use the following values:

Dead weight of concrete	150 lbs. per cu. ft.
Construction live load on floor forms	75 lbs. per sq. ft.
Pressure of concrete on columns and walls per ft. of depth	140 lbs. per sq. ft.
Coefficient of elasticity for spruce or equal	1,200,000
Extreme fiber stress in spruce or equal, for timbers	1,200 lbs. per sq. in.
for column yokes	1,800 lbs. per sq. in.
Horizontal shear for spruce or equal	200 lbs. per sq. in.
Crushing perpendicular to grain in spruce or equal	400 lbs. per sq. in.

The proper value for the equivalent hydraulic pressure of concrete to use in form design has been variously estimated all the way from 75 lbs. per sq. ft. per ft. of depth to twice that amount. The value of 140 lbs., noted above, will give safe results and is based on actual experiments under job conditions.

Timbers used as joists to support the floor forms are figured for the full live load of 75 lbs. per sq. ft. plus the dead load of the slab, on jobs where side-dump cars carrying a four-bag batch of concrete are used for distribution. Table 1 has been prepared on this basis, using the simple beam formula. This will take care of the worst case and places the greatest factor of safety where it is most needed.

On jobs where buggies, barrows or chutes are used for placing concrete, the spacings and spans given in the table can be increased because the live load will be a great deal less. It is doubtful that the full live and dead loads act at the same time in any case.

The span of the joists is usually fixed by the position of the girts. The location of the latter is determined by the column spacing in a mushroom floor and by the beam spacing in beam and girder construction. The spacing of the joists is kept as near 24″ as possible in or-

TABLE 1—SPACINGS AND SPANS FOR JOISTS

Slab Thickness, in.		3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
Weight, lbs. per sq. ft.[1]		112.5	125.0	137.5	150.0	162.5	175.0	187.5	200.0	212.5	225.0
Size of Joists, in.	Spacing of Joists, in.	Span of Joists in Ft.									
2×6[2]	18	7.2*	6.9*	6.5*	6.3	6.0	5.8	5.6	5.4	5.3	5.1
"	20	6.9*	6.5*	6.2	5.9	5.7	5.5	5.3	5.1	5.0	4.8
"	22	6.5*	6.2	5.9	5.7	5.4	5.2	5.0	4.9	4.8	4.6
"	24	6.3	5.9	5.7	5.4	5.2	5.0	4.8	4.7	4.6	4.4
"	26	6.0	5.7	5.4	5.2	5.0	4.8	4.7	4.5	4.4	4.2
"	28	5.8	5.5	5.2	5.0	4.8	4.7	4.5	4.4	4.2	4.1
"	30	5.6	5.3	5.1	4.9	4.7	4.5	4.3	4.2	4.1	4.0
2×8[3]	18	9.7*	9.2*	8.8	8.4	8.1	7.8	7.6	7.3	7.1	6.9
"	20	9.2*	8.8*	8.3	8.0	7.7	7.4	7.2	6.9	6.7	6.5
"	22	8.9*	8.4	8.0	7.6	7.3	7.1	6.8	6.6	6.4	6.2
"	24	8.4	8.0	7.7	7.3	7.1	6.8	6.5	6.3	6.1	6.0
"	26	8.1	7.7	7.3	7.0	6.7	6.5	6.3	6.1	5.9	5.6
"	28	7.8	7.4	7.1	6.8	6.5	6.3	6.1	5.9	5.7	5.5
"	30	7.5	7.2	6.8	6.5	6.3	6.1	5.9	5.7	5.5	5.3
2×10[4]	18	12.2*	11.6*	11.0*	10.6	10.2	9.8	9.5	9.2	8.9	8.7
"	20	11.6*	11.0*	10.5	10.0	9.7	9.3	9.0	8.7	8.4	8.2
"	22	11.1*	10.5	10.0	9.6	9.2	8.9	8.6	8.3	8.0	7.8
"	24	10.6	10.0	9.6	9.2	8.8	8.5	8.2	8.0	7.7	7.5
"	26	10.5	9.6	9.2	8.8	8.5	8.2	7.9	7.6	7.4	7.2
"	28	9.8	9.3	8.9	8.5	8.2	7.9	7.6	7.4	7.1	6.9
"	30	9.5	9.0	8.6	8.2	7.9	7.6	7.3	7.1	6.9	6.7

[1]Weight includes dead load of slab plus 75 lbs. per sq. ft. live load

[2]Span which will develop 1,200 lbs. per sq. in. fiber stress and deflection of

$$\frac{\text{Span. (in.)}}{360} \quad \frac{48\times5.75\times1{,}200{,}000}{5\times360\times1{,}200\times2}=77'' \text{ or } 6.4'$$

$Mr=2\times5.75^2\times1{,}200/6=13{,}200$ in.-lbs.

[3]Span which will develop 1,200 lbs. per sq. in. fiber stress and deflection of

$$\frac{\text{Span. (in.)}}{360}=\frac{48\times7.75\times1{,}200{,}000}{5\times360\times1{,}200\times2}=103'' \text{ or } 8.6'$$

$Mr=2\times7.75^2\times1{,}200/6=24{,}000$ in.-lbs.

[4]Span which will develop 1,200 lbs. per sq. in. fiber stress and deflection of

$$\frac{\text{Span (in.)}}{360} \quad \frac{48\times9.75\times1{,}200{,}000}{5\times360\times1.200\times2} \quad 130'' \text{ or } 10.8'$$

$Mr=2\times9.75^2\times1{,}200/6=38.000$ in.-lbs.

*Deflection in this case exceeds 1/360 span

der to work the 7/8-in. panel decking to the limit. With the span and the spacing known, a timber can be selected from the table as the joist size. The spacing of joists once determined should be kept standard for the job, so that when the panels are re-used their cleats will not interfere with the joists previously placed.

Table 2 gives the spacings of posts under the girts for various spans of joists and thicknesses of slabs. These tables were calculated for a 24-in. spacing of joists. The concentrated loads from the joists were used on a simple span in calculating the bending moment. The worst case, when one joist comes at mid-span, was used in this calculation.

It will be noticed that the full live load was also used in preparing this table. However, since the full live load will never get to the girt and the span of the girt is always continuous for at least two spans, the moment of resistance of the sticks has been multiplied by 1.2.

The load on the posts is next found. This load is usually far below its allowable load as a strut, but, as has been stated, the latter may cause an excessive crushing stress perpendicular to the grain in the girt at the top of the post. It is therefore well to play safe at this point, especially where granolithic finish is to be cast with the slab. A dish in the finished floor is often caused by settlement in the panel due to this cause. A drop of 3/8″ is not uncommon if soft wedges are used.

Deflection in the floor timbers themselves need cause little worry. As seen by the tables, fiber stress governs except in very unusual cases. When it is desirable to increase the spans given in the tables in order to make a better arrangement of centering with only a slight increase in fiber stress, it is well to compute the deflection.

COLUMNS

Tables 3 and 4 give the spacings of wooden column yokes for a bolt-and-wedge scheme. A fiber stress of 1,800 lbs. per sq. in. has been allowed and the load on the cleats determined by using the concrete at 140 per sq. ft. water equivalent. The span of the yokes has been taken c. c. of bolts, allowing 2½″ for column sides, the thickness of the yokes, and 1″ for wedging. This gives a greater bending moment and heavier yoking than in some tables that have been proposed by others. For example, one well known author on concrete work in a published table gives five 2-in. x 4-in. yokes on edge for a 30-in. column with 10-ft. head. I have seen a column fail under similar conditions when yoked with seven 3-in. x 3-in.

On our work we have used several styles of patented metal clamps and have always found that the manufacturer advocates a much greater spacing than we have found allowable on the job. In one case, we used eight adjustable steel clamps of a certain make on a 24-in. x 24-in. column 13′ 5″ high. We noted considerable deflection in the clamps. We asked the makers for their recommendation for yoking a column of this size and height and their answer was "four or five clamps would be sufficient." We had practically the same experience with another make in regard to recommendation for spacing their clamps. I believe manufacturers would do well to make some study of actual conditions before putting their products on the market.

The deflection of the column sides between the yokes will never need attention except when very large yokes are used. The limiting span for boards is shown in Fig. 2. In most cases when yokes are properly spaced for strength and for action on the bolts the spacing will be well within the limits for the boards.

WALL FORMS

A cheap method of centering a wall 6′ high and over is to use full-height vertical panels, heavy horizontal studs, heavy vertical liners or standards and large rods threaded at both ends, with suitable plate washers to give proper bearing for the load on the rod. By this scheme the stock can be stressed nearer to its allowable load and fewer ties used

TABLE 2—SPACING OF GIRTS IN FT.

Slab Thickness, in.											
Weight, lbs. per sq. ft.[1]		3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
Size of Girt, in.	[2]Span of Girt, ft.	112.5	125.0	137.5	150.0	162.5	175.0	187.5	200.0	212.5	225.0
3×6	3	12.3	11.1	10.1	9.3	8.6	7.9	7.4	6.9	6.5	6.2
"	3.5	10.6	9.5	8.7	7.9	7.3	6.8	6.4	6.0	5.6	5.3
"	4	9.3	8.4	7.6	7.0	6.5	6.0	5.6	5.2	4.9	4.7
"	4.5	6.8	6.1	5.5	5.1	4.7	4.3	4.0	3.8	3.6	3.4
"	5	5.3	4.8	4.3	4.0	3.7	3.4	3.2	3.0	2.8	2.6
"	5.5	4.3	3.9	3.5	3.3	3.0	2.8	2.6	2.4	2.3	2.2
"	6	3.7	3.3	3.0	2.8	2.6	2.4	2.2	2.1	2.0	1.9
4×6	3	16.3	14.7	13.3	12.2	11.3	10.5	9.8	9.2	8.6	8.2
"	3.5	14.0	12.5	11.4	10.5	9.7	9.0	8.4	7.9	7.4	7.0
"	4	12.2	11.0	10.0	9.2	8.5	7.9	7.3	6.9	6.5	6.1
"	4.5	8.9	8.0	7.2	6.6	6.1	5.7	5.3	5.0	4.7	4.4
"	5	7.0	6.3	5.7	5.2	4.8	4.5	4.2	3.9	3.7	3.5
"	5.5	5.8	5.2	4.7	4.3	4.0	3.7	3.5	3.3	3.0	2.9
"	6	4.9	4.4	4.0	3.7	3.4	3.1	2.9	2.7	2.6	2.4

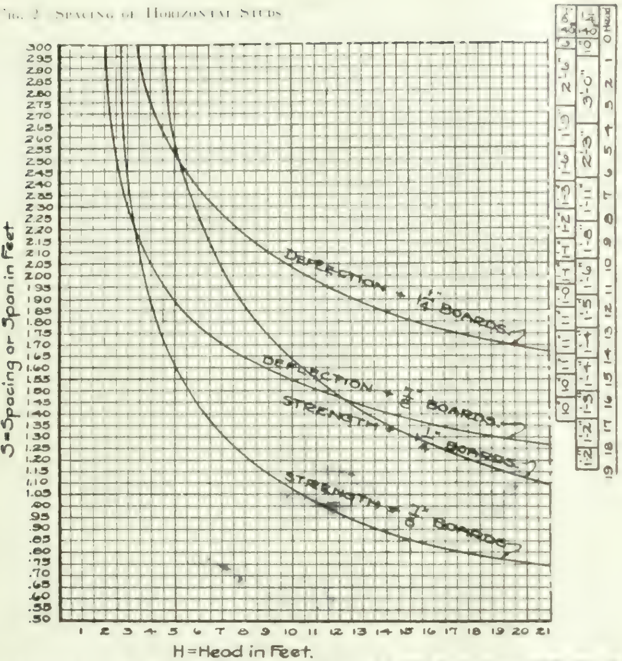
[1]Weight includes dead load of slab plus 75 lbs. per sq. ft. live load

[2]Span which will develop 1,200 lbs. per sq. in. fiber stress

For 3×6-in. girts, $Mr=35{,}000$ in.-lbs.$=Mo\times1.2$

For 4×6-in. girts, $Mr=33{,}000$ in.-lbs.$=Mo\times1.2$

Fig. 2—Spacing of Horizontal Studs



Maximum fiber stress, 1,200 lbs. per sq. in.; M = 0.1 WL²; Deflection = 3WL³/384 EI

Head	Largest Col. Dia. in Inches.								
	P.P.	16"	18"	20	24	28	30	32	36
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	1702 1420 1095 .0740 .0637 .0598 .0525 .0479 .0463 .0436 .0397 .0376 .0350 .0345	43 36 24 19 18 15 13 12 12 11 10 10 10	40 33 22 17 15 14 12 11 11 10 10 9 9 8 8	37 31 21 16 14 13 11 11 10 9 9 9 8 8 8	31 27 18 14 12 11 10 9 9 8 8 8 7 7 6	29 24 16 13 11 10 9 8 8 8 7 7 6 6 6	27 23 15 12 10 10 8 8 7 7 7 6 6 6 6	26 22 14 11 10 9 8 7 7 7 6 6 6 5 5	24 20 13 10 9 8 7 7 7 6 6 6 5

Mr 3"x4"=14400

H =head to develop strength of yolk.

$$H = \frac{296000}{L^2+26L}$$

P.P.=proportion to H

Table based on 140 lbs. per Sq In. unit presure.

Table 3—Spacing of 3-in. x 4-in. Wooden Column Yokes for Max. Fiber Stress of 1,800 Lbs. Per Sq. In.

Size	Largest Col. Dia. in Inches.								
4x6	36	40	44	48	52	56	60		
3x6			36	40	44	48	52	56	60
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	42 35 22 18 16 14 12 12 11 11 10 9	39 31 21 17 16 13 11 11 11 10 9 9	37 30 19 16 14 12 11 10 10 9 9 8	34 28 18 14 13 11 10 9 9 9 7 7	31 26 16 13 12 11 9 9 8 8 7 7	29 27 15 12 11 10 9 8 8 8 7 7	28 23 15 12 10 9 8 8 7 7 7 6	26 21 14 11 10 9 8 7 7 7 6 6	24 20 13 10 9 8 7 7 7 6 6

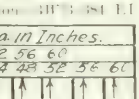


Table 4—Spacing of Wooden Column Cleats for Max. Fiber Stress of 1,800 Lbs. Per Sq. In.

through the wall. Fig. 3 gives a typical cross-section for this scheme. There are so many unknowns entering into calculations for wall centering that any tables are of doubtful value. It should be noted that as a rule the head of concrete in a wall is limited by the amount that can be cast by the placing outfit in an hour. Ordinary concrete begins to set up in this space of time so as to lose much of its hydraulic effect. Using this height and 140 lbs. per sq. ft. pressure will give safe results. It is economical when high heads occur to limit the height to which the concrete can be cast in order to use lighter forms. A system which requires a large number of rod or wire ties is decidedly uneconomical.

DRAFTING ROOM METHODS

More important to the success of the job than the values used in the calculations are the methods employed in the drafting room in turning out drawings of forms accurately and speedily. The man in charge should be experienced in the different types of concrete building construction and should have men whose judgment of building work is reliable. With such an organization form details can be prepared in advance in the office, leaving the job superintendent free to work out the many other details attendant upon the beginning of the job. The carpenter foreman can also use his whole energy in directing the carpenter labor and the carpenters will need only to use their tools to assemble the panels made up in advance.

The first study and drawings to be made form a general assembly. Usually several different combinations of timbers and methods of assembling the panels are sketched up and compared as to cost. Other things being equal, of course, the cheapest design is adopted.

A record of costs of the various units which go to make up the complete centering scheme is therefore necessary. Contractors who do not have such a record will find Taylor and Thompson's *Concrete Costs*[5] a valuable guide in this work.

Points to be remembered in this study are:

1. Joists and girts should be in as few lengths as possible to save time in sorting on the job.
2. Use stock sizes and lengths lumber.
3. Keep number of panels and pieces to a minimum.
4. Provide easy stripping.
5. Allow clearance enough for slight inaccuracies in making up and erecting, swelling of panels, etc.
6. Panels should be a whole number of boards in width, if possible, for ease in making up.
7. Units to be as big as can be

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[5] John Wiley & Sons, publishers, N. Y. C.

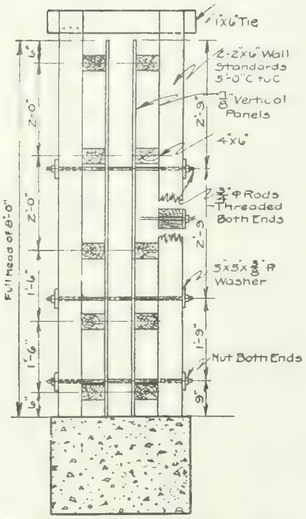


Fig. 3—Assembly of Wall Forms

handled and joists used as panel cleats where possible.

8. Provide for re-use of panels.
9. Beams to be handled as trough units when the job is regular and units can be re-used.
10. Consider use of floor domes or inverted boxes when beams are close together. In this way beam sides and slab are erected, stripped and moved as a unit. When either of the last two systems is used the beam sides should be given a slope to prevent hard stripping.
11. Provide for re-shoring if necessary.
12. Have bracing above men's heads.
13. When four beam haunches occur at a column consider making haunches as a unit similar to a column head in flat-slab construction.
14. Consideration of steel forms.

The general assembly shows how the various parts are to be put together, supported, tied and braced to resist the concrete pressure and the weights coming upon the members. This drawing in its final shape can be made on tracing cloth with soft pencil. The dimension arrows, lettering and figures should be inked so that clear prints can be made to avoid errors in the field. These assemblies should be filed permanently for reference on future work. Fig. 4 shows a typical assembly for flat-slab construction.

When it is necessary to strip the floor centering for re-use before the concrete has been in place long enough to gain its full strength, provisions for proper support of the green slab must be made in the design of the floor forms. The safest and cheapest method of doing this, in the writer's opinion, is to place boards between the floor panels and wedge posts up to a bearing under these boards before the centering posts are knocked out. In this way the slab is never left unsupported, as is the case when reposts are placed after all the centering is down. These boards should be placed according to a plan and located so as to shorten the spans of the main reinforcing bands.

After the general scheme for the forms has been decided upon, the detail panel drawings are prepared. By panel, in this paper, is meant several boards cleated together into

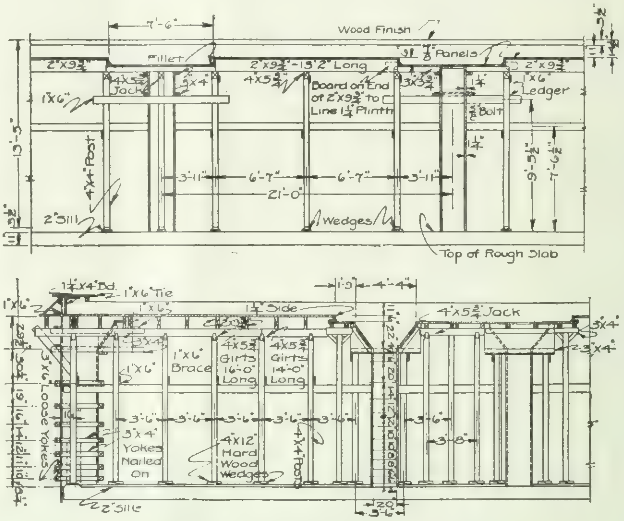


Fig. 4—Typical Assembly of Floor Centering; Above, Section B. B.; Below, Section A. A.

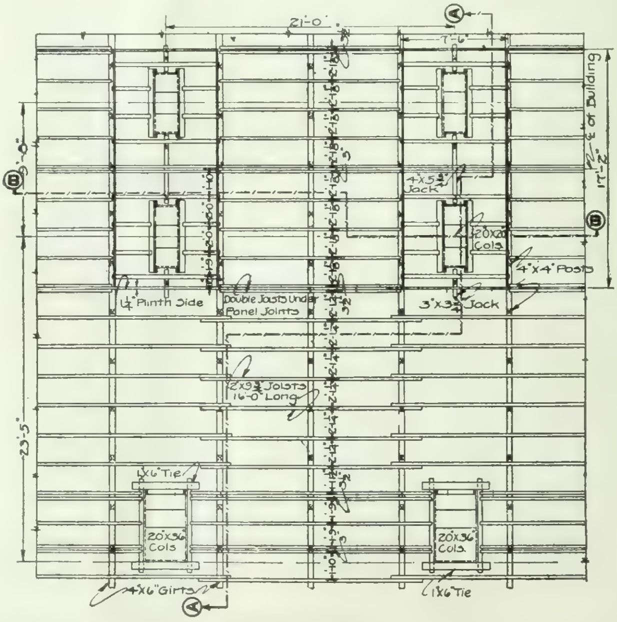


Fig. 5—Typical Assembly of Floor Centering

a unit to be used as a form for some part of a concrete member. Every different size panel is first sketched roughly on standard 6-in. x 9-in. sketching pads. These pads have holes punched at the top so that as sketches of the different kinds of panels are made they can be bunched together and brass rivets put through the holes. These sketches are transferred in more detail to thin tracing paper. The standard sheet is 25″ x 33″, divided by a 1-in. space into two halves of five spaces each. These details are used at the job mill for making up the panels. The blue-prints sent to the mill man are cut up into the 5-in. x 16-in. units, with one detail on each, and given to the carpenters at the "making-up" benches. On the detail sheet for each panel is given the panel mark, which is stenciled on the finished panel, with the number wanted and floor on which they are to be used. The sizes of the stock, dimensions and alterations, when panels are to be re-used, should be clearly marked.

A system of symbols as follows is easily learned by the workmen and should be kept standard:

B—Beam side; BB—Beam bottoms; F—Floor slab panels; P—Plinth forms;. H—Haunch forms; C—Column sides; W—Wall panels.

Thus B18 means beam side No. 18 and its location is shown on the key plan.

These detail sheets can be drawn up entirely with soft pencil on paper as they are not valuable after the forms are once made. Rubber stamps for a great deal of the lettering will save time.

Where time allows and plans are complete, it is advantageous to get out one kind of panel at a time. In any case the first panels to be sent to the making-up mill should be typical floor panels. These can be used economically in building foundation walls, etc., and in this way the job can get an extra use out of them.

It is impossible to get a satisfactory cost unit for doing this form drawing. A price per sq. ft. or per detail varies widely, according to the number of details required and the number of sq. ft. that can be made from one detail in different buildings. A big building, where a large duplication of the different kinds of units is possible, will cost much less per sq. ft. for this work than a small building which is badly cut up. The average cost per sheet has been found to be about $4.50 complete. This includes time spent on studies, assemblies, key plans, scheduling and checking. The number of sheets required on buildings of different sizes of the same type is fairly uniform according to the size. The number varies from 30 sheets on a small building up to 100 or more on a large building with irregularities. By reducing the cost of the sheets to drafting room hours by dividing the probable total cost by the average rate per hour, a fairly close estimate of the number of men required to turn out a job in a specified time can be made. This is useful on rush work.

The key plan mentioned above is really a diagram of the floor plan upon which is shown the location of the various form panels. This plan is the only one which the workmen consult in erecting the form work. It must, therefore, be complete and clear.

This plan can best be made by tracing the floor plan on cloth from a blue-print, indicating the beams and holes in the floor and the columns and walls in the story below. The lines should be heavily inked and the figures large enough and spaced so that the tracing can be photo-reduced to convenient size for the foreman to handle on the job. A big blue-print is inconvenient and fades in the strong sunlight. As a rule, to avoid misunderstnadings, a key plan should be prepared for each floor in the building.

The key plan may be supplemented by a letter to the job in which should be noted assumptions made in preparing the details. These notes might include such information as clearances allowed, grades at which forms are to start, scheme for re-use, etc.

Fig. 6 shows a convenient form to use in scheduling the panels. A schedule is made for each different kind of panels. This form is especially useful on a rush job where forms for one floor at a time must be completed. The additional number of each kind of panels already detailed, to be made up for each floor after the first, can be shown on this schedule.

MATERIALS

The materials to be used for the form work should be scheduled from the form drawings and not ordered by guess, as is so generally the custom. If complete form drawings for the job are available in time, it is economical to order even the boards for column and beam forms to exact widths and lengths to make up the panels. This saves ripping and cutting off the boards in the job mill, where the saws are often taxed beyond their capacity at the beginning of the job getting out miscellaneous stock.

It is always desirable to get the lumber in car-loads because of the lower price. For this reason, on many jobs, in order to get the stock in time from mill shipment, it is necessary to prepare the schedule from the general assembly and typical details.

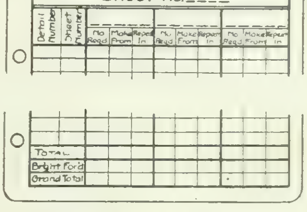
The joists, girts, posts, braces and sills can be taken from the general assembly plan directly by multiplying the stock required for a typical bay by the number of bays in the building and the number of floors of centering needed. Girts and joists should be ordered edged in order to obtain an even bearing for these members.

The board feet of ⅞-in. roofers for slab and wall panels can be taken off directly from the sq. ft. of floor and wall surface, adding at least 10% for waste and 25% for cleats. As these come in random lengths it is desirable to specify the length preferred, so as to get as big a percentage as possible of this length.

One and one-half-in. boards for column and beam sides and 2-in. plank for beam bottoms should be ordered P-4-S. Boards 7¾″ and 5¾″ wide after planing are the most useful widths for beam and column sides and can be ordered in random lengths, specifying again the lengths desired for as big a percentage as possible. The best length for the majority of columns and beam sides and the best width for beam bottoms can be easily taken from the plans by one familiar with form work.

Stock for beam cleats and column yokes can be ordered rough and the quantity can be closely estimated from the assembly plan. Rough plank and timbers for staging and runways should also be included in the order.

By getting a schedule of the form lumber in this way as soon as possible after the contract is secured,



Schedule Of
______ FORM DETAILS
Job No.____ Building _____
Sheet No.____

Detail Number	Sheet Number	No Reqd	Make From	Repeat In	No Reqd	Make From	Repeat In	No Reqd	Make From	Repeat In
Total										
Brght For'd										
Grand Total										

Fig. 6—Blank Form for Schedule

there is usually time for a thorough canvass for prices and delivery. At the same time the contractor knows that the quantity called for on the lumber schedule takes care of and is suitable for the needs of the job. In this way the very lowest price is secured on the majority of the stock needed for the building.

METAL IN FORM WORK

From the assembly of the columns and walls a schedule of the number and lengths of rods and fittings needed for tying the forms together can be made and the order placed early.

Sheet metal can be used economically in forming an octagonal head at the top of a square column. When the column sizes do not change in different stories the design is simple. We have, however, used successfully one set of metal heads on square columns ranging from 38″ in the first story to 20″ in the top story. The adjustment was made by using a plate on each side of the head in which were punched lines of bolt holes spaced for the reductions. Black sheet metal, No. 22 ga., is usually sufficient for these heads and can be easily worked by the sheet-metal men.

There are several schemes of patent adjustable metal centering and column yokes on the market which have merit for particular cases and should be investigated when considering form material.

Corrugated sheet metal for slab forms can be used economically on some buildings, especially those of the flat-slab type. The corrugated ceiling, however, is objectionable to some owners. When a large number of inserts need to be placed the use of metal sheets is of doubtful economy because it is more difficult to attach the inserts to the metal forms.

The sheets are laid over the wooden joists, lapping the metal at the ends and sides. These sheets can be re-used many times and re-corrugated on the job. When unfit for forms the sheets can still be used for concrete chutes and as siding for temporary buildings on the job.

Surface Treatment of Picaza Bridge, Argentine[1]

The Picaza bridge over the Salada river in the province of Buenos Aires, Argentine Republic, consists of a central span of the through arch type of 85′ length and six approach spans of 93′ 6″ each. The central span consists of a floor system of transverse concrete beams and a slab deck suspended by steel tension members from two concrete arch ribs, each reinforced with a structural steel skeleton arch rib, the ends of which are connected by a steel chord to take the arch thrust. The hangers are bolted to the chord, and all tension members are encased in concrete. Roller bearings at one end provide for expansion and contraction and two transverse arches provide wind bracing and otherwise help to make the structure more rigid.

Each approach span consists of three continuous reinforced concrete beams resting on three supports. The central supports are concrete pylons, to which the beams are rigidly fixed, while the end supports are masonry pillars, steel bearing plates on pillars and beams, face to face, allowing free temperature movement. The floor and the sidewalk are carried on a transverse beam and slab system.

The methods of surface finish and ornamentation employed on this structure are unique and therefore of particular interest and are here given in detail.

Ornamentation—After concreting the arch span, the masonry of the central pillars was finished and the ornamental designs at the crowns of the arches and at the haunches were added by grouting behind plaster of paris negatives, held in place by wiring and bracing. Granite mosaic work was used to fill the decorative triangular panels above the haunches of the arch ribs, this mosaic giving a very effective and beautiful contrast to the concrete.

Ornamental brackets on the approach spans were cast at some distance from the bridge site, on a foundation of expanded metal. These were hollow and carefully hammer-dressed to resemble cut stone. They were tied in place to the sidewalk reinforcement through tubes left in the concrete, which were afterward grouted and sealed from above.

Surface Finish — All masonry above the level of the coping was plastered with 1:2 sand mortar and, after hardening, was hammer-dressed to give the appearance of cut stone. The copings were plastered with the same mortar but combed with a fine steel comb, to give an imitation cut stone. This method is being effectively used in Argentine on nearly all buildings of architectural merit.

Below the coping level a rough granolithic surface was secured by first making longitudinal grooves with cement mortar and, when these were hard, plastering between the grooves with granite chips and subsequently cleaning the surface. This produces a granite surface which reflects the light and is broken by smooth, horizontal lines, a combination which contrasts well with the smooth pylon columns.

The exposed sides of the approach spans were left rough and scrubbed with wire brushes; then a coarse sand mortar was rubbed on the rough surface with the aid of small grindstones, two coats being applied, the second on the first before it had set. In this way a hard, impermeable, rough surface was obtained, which at a distance of about 10′ can hardly be distinguished from the hammer-dressed portions. In this connection it is pertinent to call attention to the fact that a surface of uniform color and texture was desirable because the necessary use of different cements on different spans had produced a variety of shades, not at all pleasing, and this finish corrected this defect.

The upper and the lower surfaces of the arch ribs were finished smooth, while the hangers and tension members were plastered on the picked concrete in order to obtain the curves of the design. The sides of the arch ribs were well picked and then plastered with fine granite chips and wire-brushed 12 hrs. afterward to remove the cement coating, a fine and very satisfactory granolithic surface being obtained. The under surfaces were simply washed with cement to produce a uniform tone.

In all cases the objects were to obtain a uniform tone, to break up the light, and at the same time, to avoid monotony in the appearance of the different classes of surface. These objects were achieved, although, as the granite used is of exactly the same color as the cement, far greater and more pleasing contrasts could have been obtained with an aggregate of a different color.

The appearance of the bridge is pleasing, a near view giving an idea of massiveness, while at 3,000′ an impression of extreme lightness is conveyed. After a year of sun, frost and floods a few cracks have appeared in the mortar plastering, but always near or at expansion joints or bearings of the concrete beams and these in all cases have been due to the fact that the plastering of the brickwork was not isolated completely, by cutting from the movable beam surfaces.

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[1] Abstracted by A. M. Wolf from a paper by A. A. Agramonte, Assoc. Mem. Am. Soc. C. E., in the May, 1915, *Proceedings* of the Am. Soc. C. E.

Further Consideration of Road Conference Committee Reports

Following is a continuation of the summarization of the reports of committees of the Second National Conference on Concrete Road Building as begun in the March 1916, issue. Every road builder will profit by a careful consideration of the ideas developed by this large and capable body of road engineers.

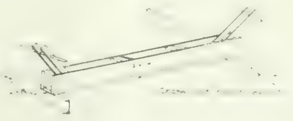
Committee 8 — Mixing and Placing Concrete

CHAIRMAN, ERNEST McCULLOUGH;[1] JOHN WILSON,[2] ERNEST ASHTON,[3] G. E. SCOTT,[4] A. D. WILLIAMS.[5]

The Committee on Mixing and Placing Concrete not only took up more in detail the matter of consistency which was also considered by Committee 7, but went into the details of placing concrete in various consistencies and by a series of tests determined something of the value of various mixtures and consistencies and the strength given in the resulting concrete. The report of this committee is particularly interesting in view of the fact that the committee considering this same phase of concrete road construction in the first conference on concrete road construction two years ago went on record in favor of the boom and bucket method of placing concrete as against the chute method. The committee two years ago was of the belief that in order to place concrete successfully with the chute it was necessary to have it too wet to get good results in road construction, while the present committee declared itself more or less neutral on this subject but opposed to the use of horse carts in distributing concrete and also against the use of wheelbarrows and handcarts, as the latter require more time to complete the work of depositing concrete for a single slab than is consistent with good practice. The committee says:

> We can see no reason for favoring one method over the other. Good results have been reported by users of the chute and good results have been reported by users using the bucket and boom method for distribution. It is believed, however, that when buckets are used the preferable type is one that dumps without overturning. Many users reported that buckets discharging by the opening of flap doors in the bottom had to be adjusted carefully so that stones would not so lodge as to prevent closing. Unless the bottom is closed completely there is serious leakage of thin rich material.

It seems here that further investigation will be necessary to determine this point in view of the way the matter of consistency is taken care of further on in the same report. The danger of leakage by a thin mix would not be great if the mixture were of the consistency recommended. Then, too, the difficulty from stones lodging in the door at the bottom of dump buckets would depend a great deal upon the construction of those doors and the way in which they open and close. It seems that further consideration of this subject will be necessary to form any valuable opinion on this particular phase of mixer construction. In arriving at its present attitude as to the value of the chute in placing concrete in concrete road construction, the committee acknowledges the co-operation of the T. L. Smith Co.[6] in a series of tests using its new high drum mixer with chutes for placing the concrete. In connection with this test the committee recommends that the chute method of distributing concrete for mixers is good when properly used. The committee recommends that the incline of the chute be steep enough to deliver concrete of proper consistency. The committee points out that if a contractor attempts to cover a considerable area with his chute he is liable to work the chute at too flat an angle and to use too much water in order to make the concrete flow readily. The committee believes, as a result of the tests mentioned, that the incline should be approximately 20° and the maximum amount of water should be 6 lbs. to 1 cu. ft. loose material. With this quantity of water, concrete ordinarily would not flow fast enough for the average contractor on the 20° slope recommended, but after a little time the material flows faster owing to the smoothing of the chute by the grinding and cleansing action of the wet concrete. It is better to increase the pitch of the chute than to increase the amount of water.



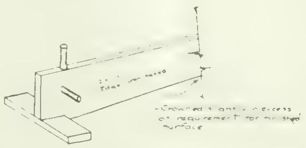

Crowned slightly in excess of requirement for finished surface

FIG. 1 — TAMPER FOR CONCRETE ROADS

FIG. 2 — END OF STRIKEBOARD, SHOWING SHOE FOR RIDING THE FORM, AND HANDLES

A STRIKEBOARD

A part of the report of this committee was taken up with the suggestion as to a strikeboard used in the manner of a tamper to give a firmer and more dense surface than can be secured from the shearing action of the ordinary strikeboard. This tamper for concrete road work was used by G. E. Scott, a member of the committee, on his own work and it has given satisfaction. It is shown in the accompanying illustration. The construction is simple, the strikeboard being crowned slightly in excess of the finished road requirements, while the tamper is finished to the exact cross-section of the finished road. After the concrete is struck off in the usual way for 10′ or 15′, the center being left slightly high, the tamper is used by two men and moved forward a few inches at each application until the strikeboard is reached. In addition to giving the benefits of tamping for density this brings the moisture to the surface, so that very little floating is necessary to secure a nicely finished road. Mr. Scott claims no originality for the device but believes that it will prove as satisfactory to others as it has been to him. This, however, is somewhat at variance with the opinions expressed in other reports and during the discussion of other reports in connection with the value of hard aggregate at the surface of the concrete road. It seemed to be Mr. Scott's idea that the mortar should be brought to the surface to make finishing easier, while the general opinion is that the aggregate should be kept as near the surface as possible to stand the actual wear caused by traffic, rather than the mortar which binds and holds it in place.

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[1] Consult. Engr., Chicago

[2] Consult. Engr., Duluth, Minn.

[3] Chem. Engr., Lehigh Portland Cement Co., Allentown, Pa.

[4] Contr. Engr., Norwalk, Ohio

[5] Chf. Engr., W. Va. State Road Bur., Morgantown, W. Va.

[6] Milwaukee

TEST OF HIGH DRUM MIXER

The report of Committee 8 includes a detailed account of tests made with the high drum, chute delivery mixer of the T. L. Smith Co.[6] In connection with the account of these tests the committee said that it hoped that before the next conference all of the leading mixer manufacturers will have arranged for a test of a battery of mixers of the principal types. Such a test, the committee says, should be arranged so that loose materials could be sent to various mixers from one bin in certain predetermined quantities and mixed for the same length of time in each mixer. They should also consider the size and shape of mixer drums, the form of mixer blades and all the prominent features which now enable salesmen to put forward selling arguments in favor of a particular mixer. The committee says that until such a comprehensive battery test can be made the committee believes that the following points should be observed in mixing concrete for road work:

1. The mixer drum should revolve at a speed not exceeding 16 r. p. m.
2. The minimum number of revolutions for each batch should be 10.
3. The minimum length of time for mixing each batch should be 1 min.

In experiments in mixing for various lengths of time, the committee found that water was not worked through the mass in less than 1 min. A much smaller quantity of water can be used, the committee reported, with long time mixing than with short time mixing and the same degree of fluidity obtained. The committee considered it necessary to have each batch mixed no less than 1 min. if the amount of water mentioned as a maximum is to be used.

While this feature has not heretofore been considered to any great extent in road construction, it is commonly known in concrete stone manufacture, particularly in the use of sand molds, that long mixing is necessary to get an even distribution of the water and an even flow of the material. The committee found that when the batches were mixed for less than 1 min., the discharge was uneven and there was a marked difference between the first and the last concrete discharged from the chute. In ordinary work, owing to the very large quantity of water used per batch, this has not been marked enough to cause comment. Rapid mixing requires considerable water to secure uniformity in the appearance of the mixed concrete and as the quality of concrete is usually fixed by the eye too much water has been used.

The tests at the Smith plant were made by the following men: Ernest McCullough, John Wilson, G. E. Scott, Prof. R. P. Davis, all members of the committee, and H. J. Kuelling,[7] W. M. Kinney[8] and C. M. Powell,[9] besides numerous officers and employees of the manufacturing company.

Specimens were tested by Prof. Duff A. Abrams.[10] Tests were made with hydrated lime added to the mixture and these were commented upon by Mr. Ashton in an appendix to the report. It was noted in making the test specimens that there was a tendency for water to appear on the surface of the hydrated lime cylinders soon after they were struck off. This may be objectionable, providing a finished surface is required, but more tests should be made with concrete containing hydrated lime before conclusions can be drawn.

A few tests were made of time of mixing. The half-minute batch was too dry to flow. The quarter-minute batch came out very dry at first and very wet at the end. No sample was taken. The other batches were all right but very stiff, making what was considered the ideal consistency. They had to be assisted down the 20° slope. It was noticed that the longer the time of mixing the more uniform the distribution of water. The mixer used was the Smith Chicago Paver No. 507,[11] the capacity being 7 cu. ft. per batch (wet batch rating). A 12-ft. chute was used and for practically all of the work the entire length was utilized, the concrete dropping to a steel plate from which it was shoveled into the molds. An automatic device measured every batch of water going into the mixer drum.

In conclusion the committee says in part:

> The mixer throughout was operated at the rate of 14 r. p. m. If the suggested battery mixer tests are made through the collective enterprise of a number of manufacturers the disputed question of r. p. m. should be settled. Your committee believes it well to call attention to the fact that chutes shorter than 20′ should not be confused with concrete spouting devices several times as long. The latter are at present on trial; the short chute is an ancient device. Your committee cannot report in favor of the bucket and boom as opposed to the chute, nor can it say the chute is better. There should be no preference expressed for either on the score of improved quality of concrete. Other considerations will probably influence the selection of either type.

An analysis of the tests and experiments made reveals the fact that the *ideal* mixture of concrete for road construction could not be handled in the equipment available, it being too dry and sticky. This ideal mixture for road construction is very stiff and pasty. In the committee tests this ideal mixture, No. 1, contained 4.6 lbs. of water per cu. ft. of loose material; No. 2 contains 5.2 lbs. of water, and No. 3 contains 6 lbs. It was found that 6.5 lbs. of water per cu. ft. of loose material was too much and gave a surplus of water on the surface of the concrete when it was placed. The amounts of water are to be considered here strictly as having been used with a mixture consisting of 1 cu. ft. of cement, 2 cu. ft. of sand and 3 cu. ft. of gravel, stone being 1-in. and under. Larger stone in the mixture would undoubtedly require less water to give it a like consistency. These amounts of water cannot be considered as absolutely standard, however, because it is well known that there are wide variations in the moisture contained in materials as used on the work. There will be considerable variations between the stone and sand which have been placed on the sub-grades for some time before work begins in very hot dry weather and stone and sand on the sub-grade immediately after a rain.

Tests with hydrated lime in the mixture to the extent of 5%, 10% and 15% by weight of the cement, showed that there was no greater freedom of movement in the mixed concrete without increasing the quantity of water in the mixture. This might, however, have been expected, as it is known that hydrated lime takes up considerable moisture and that in order to make available the quality of lubrication which hydrated lime is said to give, it is necessary to use enough water to satisfy the lime content of the mixture. In the use of hydrated lime it seems important to learn whether the moisture taken up by the hydrated lime is actually used in the concrete mixture in the hydration of cement or left on the surface after the concrete is placed and struck off; also whether the moisture is given up rapidly or the hydrated lime takes the water in surplus to be given off later on, resulting in considerable contraction due to the escape of the moisture. The committee did find that hydrated lime prevented segregation of the materials.

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[7] Highway Commr. of Milwaukee Co., Wis.

[8] Insp. Engr., Universal Portland Cement Co., Chicago

[9] Div. Engr., Information Bur., Universal Portland Cement Co., Chicago

[10] Prof. in Chg. of Structural Mat. Testing Laboratory, Lewis Institute, Chicago

[11] T. L. Smith Co., Milwaukee

In connection with the report of the committee, Chairman McCullough gave it as his opinion that it was a good idea to have some water in the drum before the dry materials enter it. He also mentioned that there should be some way of counting the revolutions of the drum and that a means might be devised for a mechanically operated discharge. It was pointed out in the course of the discussion of the report that the chute to some extent encourages the use of a wet mix. Norman G. Hough[12] said a word in favor of hydrated lime in pointing out that the committee's report that the hydrated lime made the mixture more sticky is obvious because no greater quantity of water was used in the mixture when hydrated lime entered it. He said that one of the principal values of the hydrated lime in the mix is a retention of a larger quantity of water to aid in further hydrating the cement.

The exact value of the material, however, in this regard will undoubtedly have to be determined by further tests. In the comments on the use of hydrated lime, Ernest Ashton said:

> 1. No greater freedom of movement of the mass was noticed; in point of fact, as the lime was increased, more difficulty was experienced in getting the material into the test forms.
>
> 2. The work done shows that with same angle and same percentage of water concrete did not flow more readily by the addition of hydrate of lime and as the percentage of hydrate of lime was increased the mass became more sticky and did not flow so readily.
>
> 3. By far the most important observation made was that the addition of hydrate of lime did prevent segregation and so much so as to make this the biggest gain that can be gotten from the use of this ingredient.

The number of specimens made was too small to make an adequate interpretation of actual values, and it is the intention of the committee to carry on this year a more extensive investigation as to the value of adding hydrated lime. In this connection we call attention to the fact that the Bureau of Standards, at Pittsburgh, has already started some work along this line.

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[12] Mgr., Hydrated Lime Bur., Pittsburgh

Committee 9—Reinforcement

CHAIRMAN, RICHARD L. HUMPHREY;[1] LEONARD S. SMITH,[2] J. S. MCCULLOUGH,[3] RICHARD L. SAUNDERS,[4] R. M. HUDSON[5]

In view of the fact that the Committee on Reinforcement brought in as its major recommendation that all concrete roads shall be reinforced, the discussion of this report was very lively indeed and the conference as a whole finally expressed as its opinion in the matter that: "Generally speaking, reinforcing is justified." The report of the committee on reinforcement of concrete roads of the First National Conference on Concrete Road Building held at Chicago in Feb., 1914, made as its closing recommendation that reinforcement should be about $\frac{1}{10}$ of 1% per ft. of width of pavement. It would appear from the report itself and the discussion that followed the report at the recent conference that while there is more information available than there was two years ago on the subject of reinforcing concrete roads this information has not had a tendency to clarify the situation and to make for a definite understanding of the reinforcing subject. This situation is emphasized also by the fact that the report of the Committee on Road and Pavement Specifications of the Am. Concrete Inst., A. N. Johnson, Chrmn., made no recommendation at all as to reinforcing but struck out the former provisions of the Institute specifications as to reinforcing, and Mr. Johnson, as chairman of the committee, indicated very frankly that no one on the committee or any of the scientific men consulted by the committee felt that he could offer any definite advice either as to the quantity of reinforcing, the kind of reinforcing, or where the reinforcement should be placed.

The Road Conference Committee's recommendations are:

RECOMMENDATIONS FOR REINFORCING CONCRETE ROADWAYS

Reinforcing—All concrete roads shall be reinforced. The joints shall not be nearer than 75′.

Reinforcement — The reinforcement shall have at least the following weights per 100 sq. ft., and areas per ft. of width and length:

		[illegible]	
Width	Weight per 100 sq. ft.	Sq. in. per ft. in width	Sq. in. per ft. in length
[illegible]	[illegible]	[illegible]	[illegible]
20	45	0.100	0.030
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

The reinforcement shall be placed not nearer than 3″ of the wearing surface of the roadway and shall extend within 2″ of all joints. Side laps shall be not less than 6″ and where end laps are necessary they shall not be less than 12″.

The maximum spacing of all reinforcement shall not exceed 12″. The minimum mesh of metal fabric shall not be less than 2″.

The cross-sectional effective area of diagonal reinforcement shall be computed on the sine of the angle between the axis of the reinforcement and the section parallel to or at right angles to the axis of the road.

All reinforcement shall be free from rust scale, paint or coatings of any character which would tend to reduce or destroy the bond.

Each member of the reinforcement shall develop a tensile strength of not less than 65,000 lbs. per sq. in. and an elastic limit of not less than 35,000 lbs. per sq. in. and be capable of bending 180° around a pin of one diameter and straightening without fracture.

Placing of Reinforcement—The reinforcement shall be so placed as to be perfectly flat and free from objectionable bends or kinks.

Where metal fabric is used the sheets shall be placed at right angles to the axis of the road, shall be fastened or tied together so as to keep them in the same plane, and so that the diagonal members of adjacent sheets shall cross each other at the splice. The reinforcement shall be placed accurately and the metal fabric held in place through the use of metallic pins pointed at one end and with a hook at the other, which shall be so driven into the sub-base as to hold the reinforcement in its proper plane.

The reinforcement must not be placed upon hardened concrete but must be so placed in the green concrete that the entire mass will harden without a seam in the plane of the reinforcement.

The reinforcement shall be so stored on the work as to protect it from the action of the elements which would cause objectionable corrosion, and it must be kept clean.

In the discussion that followed the report of the committee, it developed that in a number of instances in which concrete roads had been reinforced, cracks were very few and far between, yet the fact was presented with equal force that in other places in which concrete roads had not been reinforced just as satisfactory results had apparently been obtained. T. H. Johnson[6] rose to ask the question: "If reinforcement is to prevent cracks in the concrete road and does not prevent the cracks, why reinforce?" He said that in Sioux City they had long stretches of road without any reinforcing which were also without cracks. It was pointed out by Maj. Frees that the additional cost of a pavement with reinforcing would go a long way to maintain the cracks which developed in the road if it were not reinforced. It was generally admitted that reinforcing cannot be depended upon to prevent all cracks in concrete paving, that the tendency is merely to divide up the cracks and that instead of one large crack there may be several very small ones that apparently do no harm in the road and yet which, as it was pointed out, might leave an opening for the penetration of moisture to the sub-grade, where still greater harm might be done. If the cracks were wide enough to be noticed easily they would be maintained properly to prevent the penetration of moisture to the sub-grade. While there were strong advocates of reinforcing there persisted many strong advocates of the plain concrete road. Many took the view that reinforcing was not only unnecessary in order to obtain good results because of the small cracks which developed (in place of the large ones that are maintained) but added that the reinforcing might actually be a detriment to the road. The committee's reference to the specifications of the Am. Concrete Inst. will not apply now in view of the fact that the changes presented by the Institute committee[7] this year, leave out any definite recommendation as to reinforcing and, as Chmn. Johnson humorously put it: "Anything will now be acceptable to the committee as reinforcement for concrete roads from a railroad tie to a bed spring."

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[1] Consult. Engr., Philadelphia

[2] Prof. of Highway Engrg., University of Wisconsin, Madison, Wis.

[3] City Engr., Fond du Lac, Wis.

[4] Deputy Highway Commr., Hartford, Conn.

[5] Contr., Atlanta, Ga.

[6] City Engr. of Sioux City, Ia.

A resolution was adopted to the effect that the conference was not in agreement with the report of the Committee on Reinforcing and that the matter of reinforcing should be left to the discretion of the engineers in charge of the particular work. Here again it was maintained by the committee that the Conference could not change a committee's report, but such resolutions as it might adopt would be presented to the Committee on Resolutions for consideration in connection with the reports of the committees.

Where relief is sought from plain concrete surfaces in residence and other building construction, colored tile inserts give a pleasing result. Judgment should of course govern the number of the inserts and the variety of color. A few tile well placed add considerable beauty to the work.

Committee 10 — Joint Location and Construction

CHAIRMAN, GEORGE A. RICKER;[1] H. J. KUELLING,[2] FRED C. SMITH,[3] E. D. BOYER,[4] AUSTIN W. SUMMERS[5]

The report of the Committee on Joint Location and Construction is so brief that it is given here in full:

(A) 1. In the present state of the art of building concrete pavements, joints seem to be necessary and unavoidable.

(B) 1. Your committee is of the opinion that transverse joints should be located in concrete road pavements not less than 25′ nor more than 50′ apart.

2. We note that under favorable conditions, particularly where reinforced with embedded metal, longer sections of pavement have been successfully used.

3. In suburban roads, in what may be termed single-track pavements, joints should not be placed more than 33′ apart; for widths that may be termed double-track roads, 50′ spacing will generally be found satisfactory.

4. Results of practice seem to indicate that structural stability of road concrete is secured when the slab in length is approximately three times its width.

5. Where concrete is laid 50′ or more in width, as street pavement in villages or cities, transverse joints not more than 25′ apart are recommended.

(C) 1. Transverse joints should be not less than ¼″ nor more than ⅜″ in width and should be placed across the pavement at right angles to the center line.

2. Where curbs are used, a longitudinal joint not less than ¼″ wide should be placed between the curb and the pavement.

3. All joints should extend through the entire thickness of the pavement, and it is most important that they be constructed in a plane perpendicular to the surface in order to prevent lifting or slipping of one side or the other, especially on grades.

(D) 1. Careful spading of the mixture, in placing, next to the joints is urged, and the use of a suitably designed edging tool is recommended.

(E) 1. Protection of transverse joints in concrete by the use of metal plates is not recommended.

2. Your committee recognizes that the practice regarding protection of joint is not uniform and competent engineers and road builders differ upon the question of the necessity for the use of metal plates.

(F) 1. Your committee recommends that a suitable pre-formed joint filler be used and that said filler should be made of some plastic material that will remain soft in cold weather and will not run in warm weather.

The paragraph which says: "Protection of transverse joints in concrete by the use of metal plates is not recommended," provoked a very lively discussion, inasmuch as the advocates of metal protection plates in concrete road construction did not want it to be of record that the Second National Conference on Concrete Road Building had definitely opposed the use of such plates.

Inasmuch, however, as by the rules of Conference the reports of committees represent merely the opinions of those committees and are not subject to revision by the Conference as a whole, the statement of the committee was allowed to stand. It was urged particularly by those commercially interested in steel protection plates that under present methods of installing these plates much better results are to be anticipated than formerly when the plates were not put in so as to conform to the surface of the road throughout the width, resulting in considerable wear at the joints, due to the unevenness.

Mr. Kuelling said that in his experience he had found that many of the steel joints had been covered up by a thin layer of mortar which had soon worn away, leaving a rough spot where there was excessive wear. Richard L. Humphrey said that he saw concrete in the city of Vienna which was 10 yrs. old in which joints were made of ⅛″ of tar paper, giving excellent satisfaction, with no steel protection whatever.

It was said that while the New York State Highway Dept. had made use of creosoted wood strips at the joints in some concrete roads this joint is not in favor because it leaves too wide an opening.

Committee 11 — Expansion and Contraction

CHAIRMAN, F. E. TURNEAURE;[1] PAUL D. SARGENT,[2] GAYLORD C. CUMMIN,[3] W. A. MCINTYRE[4]

The Committee on Expansion and Contraction presented a report based upon published literature, upon the opinions of highway engineers from whom inquiry was made and upon observations made by the U. S. Bur. of Standards in co-operation with W. A. McIntyre, Chf. Road Engr. of the Assn. of Am. Portland Cement Mfrs. The report of the work of the U. S. Bur. of Standards made by R. J. Wig, C. S. Laubly and W.

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[7] See Mar., 1916, issue, p. 121

[1] Ex-First Deputy Commr., N. Y. State Highway Comm., Albany, N. Y.

[2] Co. Highway Commr., Milwaukee Co., Milwaukee

[3] Consult. Engr., Philip Carey Co., Cincinnati

[4] Engr., Atlas Portland Cement Co., 30 Broad St., N. Y. C.

[5] Contr., 1010 Morgan Bldg., Buffalo

[1] Dean, College of Mechanics and Engrg., The University of Wisconsin, Madison, Wis.

[2] Chf. Engr., State Highway Comm., Augusta, Me.

[3] City Mgr., Jackson, Mich.

[4] Chf. Road Engr., Assn. of Am. Portland Cement Mfrs., Chicago

A. McIntyre is illustrated graphically and is quite detailed. The results of tests made in the vicinity of Washington appear to indicate that, under the conditions of climate surrounding them, when the effects of temperature and moisture are combined, the result is to cause a maximum expansion in the spring months when the moisture is at its maximum and the temperature is moderately warm, and that the drying-out effect of the hot summer months results in a considerable contraction, bringing the concrete to about its minimum dimension. Little change then takes place during the fall and winter, the effect of the decreasing temperature being balanced by the effect of increasing moisture.

The conclusions of the Committee of the Road Conference, however, are as follows:

That contraction and expansion are caused by temperature changes and by changes in moisture conditions, and that under climatic conditions similar to those at Washington, D. C., the effects from these two factors in concrete road surfaces are approximately of the same magnitude.

That in concrete roads, contraction and expansion are sufficient to cause frequent transverse cracks unless joints are provided.

That the actual movement in any particular case depends upon the character of the concrete and of the sub-grade. A sloppy concrete shows greater movement than a concrete mixed only moderately wet. No more water should be used than necessary to permit convenient placing and forming.

Committee 12—Finishing and Curing

Chairman, Charles Whiting Baker,[1] W. A. McLean,[2] H. M. Sharp,[3] William M. Kinney,[4] Howard W. Underwood[5]

The Committee on Finishing and Curing presented a most detailed report discussing various strikeboards, templates and finishing tools and their use. A summary of parts of the report is as follows:

The simplest pavement to strike off and finish is the road up to approximately 20′ wide without curbs. The strikeboard is shown in Fig. 1. The strikeboard rests upon the side forms and is moved forward with a combined forward and side motion like a saw. This motion fills all pockets with concrete and does not have the tendency to pull out the coarse aggregate as would a straight forward motion.

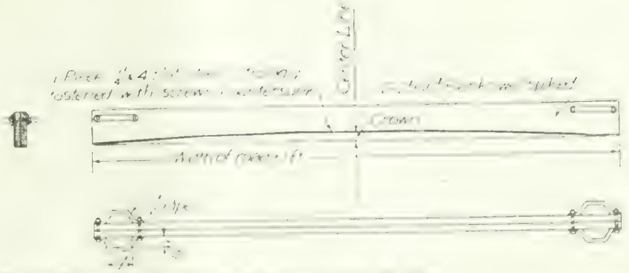

Fig. 1—Strikeboard for Concrete Roads Up to [illegible] Wide

A slight excess of concrete is always kept ahead of the strikeboard. This is usually taken care of by a workman who walks in front of the strikeboard spreading the concrete. The footprints made in the concrete by this workman should be filled with good concrete and not with a thin mortar or water which rolls in front of the strikeboard or settles into the holes after the strikeboard has passed on.

A certain amount of compacting is accomplished with the strikeboard, so that with concrete of the proper consistency it is impossible to overdo this part of the work, although striking three times will usually be found sufficient. When crushed stone of an angular nature, such as granite or trap rock, is used as the coarse aggregate, additional striking will usually be found necessary. A pronounced sawing motion will be found advantageous in such cases. This treatment has a tendency to work the mortar around the particles of stone. If at any time the striking does not produce a uniform surface, the strikeboard should be moved back and additional concrete spread over the surface with a shovel. The strikeboard may then again move forward, compacting the concrete as it goes.

To facilitate striking off and finishing, a wet mixture is frequently used. The ideal consistency of concrete for road work is that which can be struck off with only an appreciable amount of work. Water in excess of this amount detracts from the ultimate wearing qualities of the road, as it is a known fact that the resultant concrete is weaker. There is an additional disadvantage in that the excess water works to the surface in the striking off and finishing processes, bringing with it fine, light particles which offer little resistance to abrasion.

Except near joints, the striking off is usually done in the direction in which the work is progressing. When the strikeboard approaches to within about one foot of a joint, it is lifted, placed alongside of the filler or installing bar (depending on whether protected or unprotected joints are used), and then worked away from the joint. This avoids the danger of piling up material around the joint, or pushing the joint out of place into a position not perpendicular to the surface. Joints which are not perpendicular may cause unevenness due to one slab rising on the adjacent one, when expanding.

The installing bar used with metal-protected joints should not be removed until the concrete on both sides of it has been struck off. After removal of this device the concrete along the joint should be struck off with a straight-edge about 5′ long, held at right angles to the joint and moved across the pavement parallel to the center line. This will prevent a dish or hump at the joint.

Wooden side forms should be shod with 2-in. steel angles secured to the top side of the forms. This not only makes the strikeboard work easier but insures a true road surface of proper thickness by preventing uneven wear of the side forms. By having these angles project about 3″ or 4″ beyond the end of the wood at one end and set back the same distance at the other end, the alignment of the forms will be facilitated. Painting will add life to wooden forms and prevent warping.

This same type of strikeboard may be used for roads and for pavements with integral curb wider than 20′, but will usually require lateral bracing, in which case it will be found advisable also to provide a hook in the middle of the strikeboard into which a steel rod can be hooked so that a third man can assist the men at both ends of the strikeboard in moving it forward.

Where a considerable amount of street paving 20′ and more wide is to be laid, a strikeboard which can roll on the curbs is preferable. It is essential, of course, that the top of the curb shall be at an even height above the pavement and that the crown of the road be uniform in order that this form of strikeboard may be used. Strikeboards of this type are shown in Figs. 2 and 3. That shown in Fig. 2 cannot be given the saw-like motion, and considerable care must be used in its operation to obtain satisfactory results, it being practically impossible to use such a strike with crushed granite or trap rock.

On the other hand, the strikeboard shown in Fig. 3 can be operated with success on streets up to 50′ wide and will usually be found to require less labor than the strikeboard shown in Fig. 2. The board in contact with the concrete is given a saw-like motion by operating the handle at one end. Lifting devices on the carriers in both of these strikeboards raise the steel shod board in contact with the concrete above the work in order that it may be run back for successive strikings.

When a contractor has a sufficient amount of wide pavement of one width to be laid, he will benefit both through results and saving in cost by using the improved strikeboard shown in Fig. 3.

Frequently a contractor is called upon to place a pavement on a short stretch of exceptional width where the construction of a satisfactory strikeboard would

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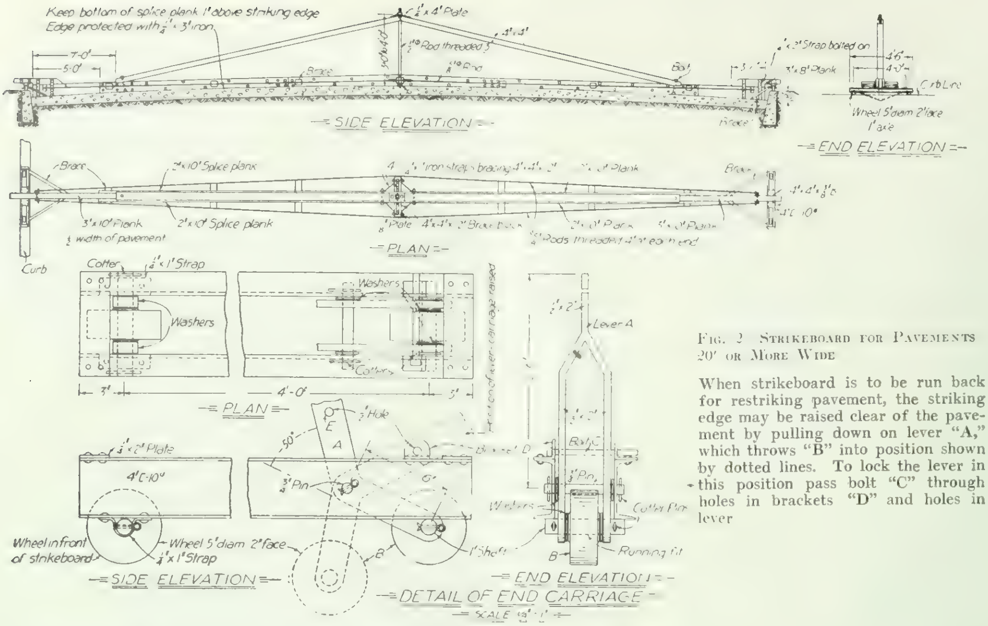

Fig. 2 Strikeboard for Pavements 20′ or More Wide

When strikeboard is to be run back for restriking pavement, the striking edge may be raised clear of the pavement by pulling down on lever "A," which throws "B" into position shown by dotted lines. To lock the lever in this position pass bolt "C" through holes in brackets "D" and holes in lever

be entirely too expensive. The following method has been successfully employed in such cases where steel protected joints are used. It is recommended with the modifications that may be necessary to meet local conditions.

A row of 2-in. x 2-in. hardwood stakes spaced about 5′ apart is driven half way between expansion joints and parallel to them. Their top should be 2″ above the grade of the finished pavement. This height is determined by a set of three sighting "T's."

Having driven this line of stakes to the proper elevation the first course of concrete and reinforcing is placed, carrying the work several feet past the stakes. This layer should be kept below the top of the stakes a distance equal to the thickness of the wearing course, plus 2″.

Across the top of the stakes 2 x 4's are nailed lightly with the 4-in. side flat. It is preferable to use 2 x 4's of a length at least equal to one-half the width of the street, as longer lengths will curve more readily to the crown of the finished pavement than will short pieces. A lap joint should be made over a stake to have a close joint over which the strikeboard will ride. The strikeboard in this case is a 2 x 8 straightedge, about a foot longer than one-half the distance between the joints. Handles are placed on each end similar to those shown on the strikeboard in Fig. 1. One end of the board is notched the proper amount so that the end resting on the 2 x 4 while striking the surface will be at the required elevation for the surface of the finished pavement.

Beginning at one side of the pavement

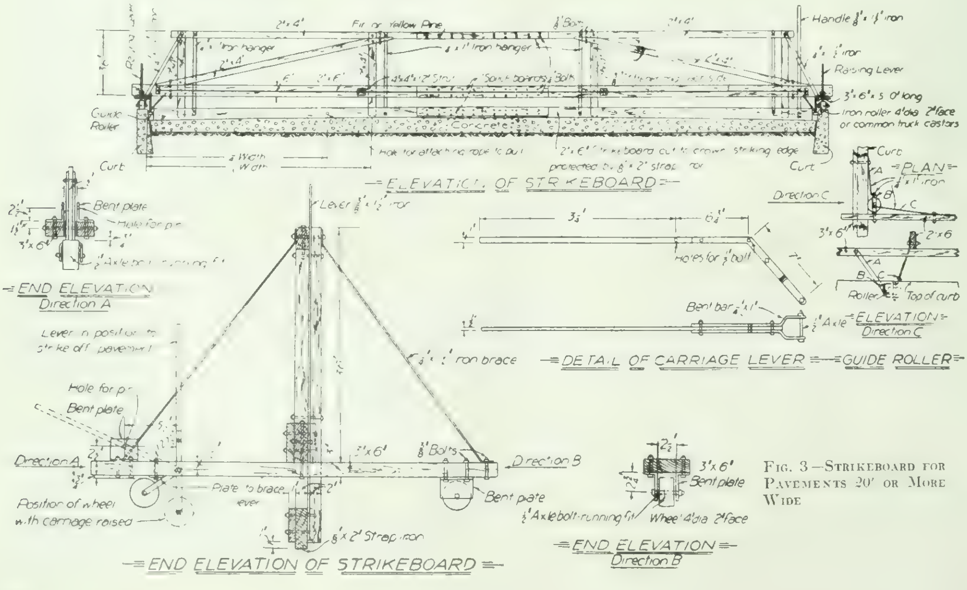

Fig. 3—Strikeboard for Pavements 20′ or More Wide

the top course of concrete is placed. One man working from a bridge works the strikeboard from the end over the joint with a saw-like motion; the other man stands in the newly laid concrete and works the board by one handle at the other end. By walking backward, his tracks in the concrete are filled with the material carried ahead of the strikeboard. One or two men spreading concrete from the bucket keep the material correctly deposited in front of the strikeboard, care being exercised to see that there is always a small surplus heaped against it. After half of the section is struck off, concrete is placed within 2′ or 3′ of the next joint, at which time the joint is installed and concrete and reinforcement are placed up to, and 2′ or 3′ beyond the joint, to the total thickness of the pavement. After removing the installing bar the pavement is struck off as before, reversing the strikeboard end for end, resting the notched end on the 2 x 4 and the other end on the joint.

After the section is struck off, the screed and stakes are removed by a man working from a bridge, stake holes are filled and the surface leveled off, if necessary, with a small strikeboard about 5′ long. Since the lower face of the 2 x 4 is above the finished surface, there is no tendency to form a line of weakness in the pavement such as would be caused if the screed were allowed to be embedded with its top face level with the surface.

It is apparent that it will be necessary to stiffen the joint in order that it may be rigid enough to support one end of the strikeboard without sagging. This can be accomplished by placing stiffeners at the center, end and quarter points of the pavement, and at other points if necessary. Pieces of lath wired tightly on each side of the joint filler, fitted snugly against the lower edge of the plates and resting on a block set in the sub-grade, will answer the purpose (see Fig. 4). The joint protection plates should, of course, be made to conform exactly to the crown of the pavement and should be wired together at the top edges with No. 16 ga. malleable iron wire, about every 12″ along their length. Care should be exercised that the wire passes through the joint filler close to the plate, so that the wire will not cut through the joint filler, and thus allow separation of the plates.

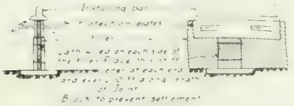

Fig. 4 Method of Supporting Joint on Wide Streets

On streets with level grade it is frequently customary to increase the crown from the summits to the inlets. This precludes the possibility of using a strikeboard which travels on the curb or side forms. A method of procedure which has been used successfully in such cases is illustrated in Fig. 5. This method can also be used in place of the strikeboards shown in Figs. 2 and 3, where only a short stretch of wide pavement is to be constructed. It is particularly adapted to work of this character where unprotected joints are used, but is not suitable for pavements over 40′ wide.

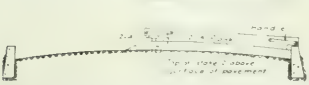

Fig. 5 —Method of Striking off Streets of Variable Crown and Wide Streets with Unprotected Joints

Stakes are driven along the center line of the pavement about 4′ apart before placing concrete. Their top should be 2″ above the surface of the finished pavement. The base concrete and reinforcing are placed and a 2 x 4 lightly nailed to the top of the stakes as in the method previously described. A strikeboard slightly longer than one-half the width of the street is cut to the crown of the pavement (average crown if the crown is variable). This strikeboard is notched sufficiently at each end so that it will ride on the center strip and curb giving the proper contour to the pavement.

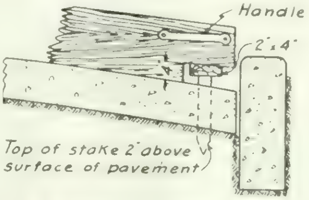

Fig. 6 Method of Supporting Strike When Curb Height Varies

If curbs already constructed are such that the height above the pavement varies from summits to inlets another guide strip placed at the gutter similar to the center guide strip can be used. This strip should be set on a line parallel to the grade of the gutter, as shown in Fig. 6. As this strikeboard strikes only one-half of the pavement, two such strikes may be used or one used alternately on opposite sides of the pavement. The guide strip and stakes are removed by men working from a bridge. Any excess material at the center or in the gutters can be worked out with a straight-edge and float.

The protection plates and installing bar for pavements with variable crown should be given the average crown. They should be ordered in two sections, each section having a length equal to one-half the width of the street. Connection for hinging together two half installing bars is made by bolting a 1½-in. x 8-in. strip to one installing bar and pinning through the other. After the joint is assembled in each bar and the bars placed in position they are connected by inserting a pin through the connecting hinge. Enough space should be allowed between the bars to provide for setting the ends of each joint at the proper elevation. Each bar is supported at the center by a metal frame containing a clamp and supported by ½-in. bolts resting on a thin wood block left in the sub-grade (see Fig. 7).

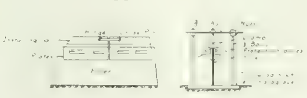

Fig. 7 Method of Supporting Joint with Pavements of Variable Crown

At street intersections it will be found impracticable to use a strikeboard and it will therefore be necessary to set stakes on about 6-ft. centers, using them as guides in placing the proper depth of concrete. Fig. 8 shows the plan of a street intersection and the letters shown represent stakes. For streets from 20′ to 25′ wide the arrangement shown will give a sufficient number of stakes, while for wider streets additional stakes should be set.

As concrete streets usually have a low crown, it has been found good practice to raise the center of the intersection an inch above the center line grade of the street between intersections. This will insure proper drainage and prevent a flat or dished appearance.

A simple method of determining the height to which these stakes should be driven is as follows: At the intersection of the center lines of the two streets set the top of the stake "A" at a point 1″ above the original level of the grade of the intersection. Set stakes "B" on the center line of each of the intersecting streets at the edge of the intersection slab and at the proper elevation as determined by the use of three sighting "T's" resting on the curbs and the stakes. Set stakes "D" at equal intervals (not exceeding 6′) from the center line of the streets toward the curb, on the lines at right angles to the center line of the streets; drive these stakes to the level of the pavement surface, which may be determined by placing the strikeboard at this point or by calculating the amount they should be below the level of the curbs and using the sighting "T's". Now set stakes "C" on the center lines of the streets at the same intervals as the "B" and "D" stakes, with their tops on a line sighted from stakes "A" to stakes "B". Finish by setting stakes "E" at the intersections of all the perpendicular "D" lines and drive them with their top to lines sighted from the "C" stakes to the "D" stakes.

To strike off this surface, first place a strip of concrete for the base course about 8′ or 10′ wide, extending from one side of the intersection to the other at right angles to the center line of the street being concreted, and lay the reinforcement on this section. Then lay a "ground" or strip of wood the thickness of the top course on top of the reinforcement about 5′ ahead of the last strip of top material which has been struck off. This "ground" must be blocked up or pressed down until level with the top of the nearest stakes and should be held in position by driving over it several pieces of ¼-in. round steel bent into the shape of a "U," with legs about 12″ long. These will hold the "grounds" in position and prevent their being floated away if a batch of concrete is dumped too close to them. Concrete for the top is then placed between this "ground" and the already finished work and struck off with a strikeboard, by using the "ground" to guide one end of this strikeboard and the already completed surface to guide the other end.

The top course material should be kept a few inches away from the "ground" to avoid making a plane of weakness which will later produce a crack. If any appreciable time elapses before the next strip of top is placed the old edge should be roughened with a shovel. This striking off may be done by the men while standing on the base material and without it being necessary for them to walk on the freshly placed top course. When this strip has been struck off, the "ground" is moved ahead another 5′ and the operation repeated.

The practice of using two "grounds," one of which is temporarily embedded in the concrete, should not be allowed. It is impossible to remove it without walking in the top course concrete, and in addition, the sharp edge of concrete which rested against the "ground" is not properly broken down nor is the new concrete, which is placed in the small trough left by the "ground," properly worked in with the older material. A plane of weakness is likely to result which later is certain to cause cracking.

The surface should be carefully watched by the foreman from different positions on the curb line to guard against irregularities of surface which are likely to occur, even with the most careful workmanship.

At the present time there is on the market a striking and finishing machine operated by power, which, after striking the pavement with a template having a saw-like motion, finishes the surface by means of a vibrating pan. Some difficulty is experienced in finishing the pavement at the joints and some hand finishing is therefore required. In addition, this machine does not allow for a moderate stiffening of the concrete between the processes of striking off and finishing, which is considered to be essential to the production of a good wearing surface. If it were possible to use a much dryer concrete than at present used with this machine, this objection might be overcome. It is believed that machine finishing has great possibilities, and it is hoped that a machine will be perfected which will do away with the uncertainty of hand work, save labor and give a surface superior to that now obtained.

FINISHING

Proper striking off puts the surface in condition to be finished with the least amount of labor and makes possible a true, even, dense pavement with the uniform wearing qualities so much desired. Too much importance cannot be attached to proper finishing, as the wearing and tractive qualities, appearance and general satisfaction of the pavement depend to a large extent on the finishing.

The pavement is best finished with a wooden hand float, the finisher working from a bridge. With this tool all small inequalities in the surface can be eliminated and the concrete worked to produce a dense surface with a texture which makes the pavement non-slippery. The hand float is to be recommended over the steel trowel or long-handled wooden float for the final finishing. The steel trowel tends to slipperiness, and while good results are not impossible with a long-handled wood float, it invites careless finishing, and good work is not generally done with this tool. For street intersections and preliminary floating where granite or trap rock is the coarse aggregate its use is permissible, but the hand float should always be used for the final finish.

Experience shows that the time of finishing has a marked effect on the wearing quality of the pavement The tendency is to finish too early. Early floating or floating immediately behind the strikeboard is to be condemned. Any saving which the contractor may make by this means is at the expense of the wearing qualities and appearance of the pavement. The work placed late in the afternoon is especially likely to suffer in this respect. In many cases this is aggravated by mixing the concrete too wet.

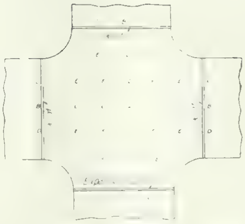

Fig. 8—Sketch Showing Method of Setting Stakes at Street Intersections for Obtaining True Crown

No definite time can be given which should elapse between the placing and finishing of the concrete as weather conditions are among the factors which must be taken into consideration. If the weather is very hot and the concrete of proper consistency and hardening rapidly, the finishing can be done very soon after striking off, but if the weather is cool, damp or cloudy a longer period must elapse. It is a matter of judgment. The appearance of shrinkage cracks on a concrete surface is evidence that either the concrete was mixed too wet, was finished too early, or subjected to conditions which caused too rapid drying out. The possibility of having shrinkage cracks is, of course, aggravated by having hot, dry stone, porous or dusty aggregate, and is considerably influenced by a dry sub-grade. Sprinkling the aggregates with water and being sure that the sub-grade is wet will be of considerable advantage. The surface of the concrete should contain practically no free water at the time of finishing and should be of such consistency that wood float marks are evident on the surface.

In no case should the surface be floated when there is any water standing on it, especially if granite or trap rock be used, as this conceals small depressions which, if floated over and left, will later be found to contain pockets of stone and insufficient mortar which will wear rapidly under traffic.

Workmen should not be allowed to walk on the concrete after it has been struck off. The finisher should work from a bridge which entirely spans the pavement and care should be taken that all foreign substances such as sticks, coal, clay and like materials appearing on the surface, are removed. Fig. 9 shows a design for a satisfactory finisher's bridge. It is simply constructed, rigid and light in weight.

If bridge is to be used with curbs which are more than 2″ above crown of pavement 4-in. x 4-in. blocks at end may be eliminated

For floating the pavement surface at intersections some means of supporting the finisher's bridge must be devised. If there is a manhole at the center of the intersection, one end of the bridge may be rested upon it and the bridge moved round in a circle with its outer end resting outside the curb line.

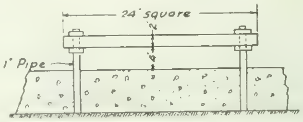

Fig. 10—Stool for Finisher's Bridge at Intersections

If there is no manhole, a support may be very simply made as shown in Fig. 10. Footprints of the workman who carries the end of the bridge out and the holes left by the legs of the stool should be filled with good concrete and not simply allowed to fill with fine mortar and then be floated over.

Where unprotected joints are used and the filler extends slightly above the surface of the pavement the split float is recommended. This is a double float, the slot in the center being slightly greater than the width of the filler (see Fig. 11). The filler runs through the slot and the concrete on both sides of the joint may be finished to the same elevation. Experience has shown that the finisher must be taught the use of this float, for if he is given it uninstructed, it will soon be discarded.

The use at unprotected joints of an edger of small radius has been suggested. The theory is good but in practice the necessary widening of the joints offsets any advantage of the rounded edges.

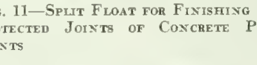

Fig. 11—Split Float for Finishing Unprotected Joints of Concrete Pavements

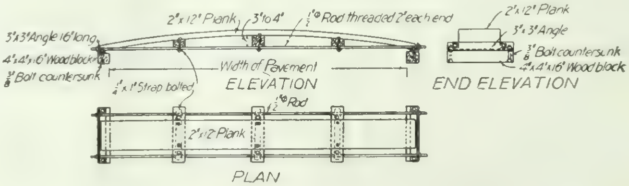

Fig. 9—Finisher's Bridge for Concrete Road Building for Roads or Streets Up To 30′ Wide

At protected joints, in order to avoid having one slab higher or lower than the adjacent one and also to avoid a hump or depression at the joint, which is very objectionable to traffic, a straightedge held parallel to the center line of the road should be run along the joint, any high places being cut down and any low places filled. The straightedge used should be about 5′ long and should be used more as a gauge than as a strikeboard.

In order to obtain a dense concrete adjacent to the joint where the steel protection plates are used, it is recommended that a steel trowel be used to finish the surface for a distance of about 6″ on both sides of the joint. By this method the concrete is brought more nearly flush with the top of the joints.

The old idea of marking concrete road surfaces with grooves or in the shape of blocks is rapidly disappearing, as such finish is unnecessary and tends to increase the chance of wear, which in most cases develops unevenly. The more recent practice of brooming the surface with a stiff brush or broom after finishing is also falling into disuse as the roughening thus obtained, formerly believed to be necessary to prevent slipping, is not required and very rapidly disappears. In addition, this treatment is likely to cause a more rapid drying out of the surface.

PROTECTION AND CURING

During hot and windy weather it will usually be found necessary to cover the surface of the finished pavement with canvas as soon after floating as possible, and to keep this canvas sprinkled for several hours. This will help to prevent the formation of shrinkage cracks.

Canvas should be available to cover at least one-half a day's work. The canvas is not allowed to touch the fresh concrete, being supported on frames. Canvas which has been waterproofed is economical because it will not be so readily affected by moisture nor by the destructive action of the cement mortar. When the concrete has had sufficient time to harden the canvas should be removed and the pavement covered with earth or other water-retaining material to a depth of at least 2″ and should be kept thoroughly wet for from 10 das. to 14 das. This protective covering should not be washed into piles in sprinkling.

Another method of curing which has been used successfully and at a cost considerably less than that of earth covering and sprinkling, is that known as "ponding." The pavement is flooded so that the water stands about 2″ deep over the crown of the pavement at the shallowest point. If there are no curbs, light dikes or banks of clay or earth about 8″ or 10″ wide and about the same height are constructed along the edge of the pavement to retain the water. If the pavement is on a grade, dikes placed transversely across the pavement are necessary. They are generally about 15′ apart and should preferably be so placed that they come over the expansion joint in order to prevent any possibility of water getting to the sub-grade at these points.

With the utmost care in planning the work, a storm sometimes occurs before all the concrete pavement is sufficiently hardened to prevent pitting and it becomes necessary to protect the surface. The most satisfactory way to meet this condition is to cover the pavement with canvas, as previously described for curing in hot weather, taking particular care in laying the canvas strips and making the laps so that the covering will shed water readily. Canvas should be supported well above freshly finished work. When a portion of the pavement laid has not been finished, the canvas can be supported on "horses" in such a way as to permit the finisher to complete his work under its shelter.

In the fall months when damp, cool, rainy weather prevails, or when the temperature averages below or rarely reaches 65° F., the concrete will harden properly if left unprotected. It may be advisable under these conditions of temperature to omit the earth covering, thus allowing the warmth of the sun during the day to hasten the hardening of the concrete, rather than to expend its heat in drying out the wet earth cover. The pavement should be sprinkled if the temperature is high in the middle of the day, but when there is danger of frost or freezing weather at night, sprinkling should be omitted on work only a day or two old.

As a protection against frost or light freezing a canvas covering should be used. Enough canvas should be provided for this purpose to cover at least one day's work. A canvas covering is much easier handled and placed than building or tar paper, and is more efficient and economical. The canvas should not be allowed to touch the concrete. The canvas should be removed the day after placing to give the pavement the full benefit of the heat from the sunshine. Should it be necessary the following night to cover the concrete again to protect it from freezing, at least 3″ of straw, marsh hay, or other similar material should be used, covering the fresh concrete with canvas and enough earth should be placed on top of the straw or some other suitable means should be used to hold it in place.

The U. S. Weather Bureau distributes daily from its various forecast stations a circular giving a forecast of the weather and temperature for the ensuing 36 hrs. These circulars will be sent free to any one making application, and those in charge of pavement work in the fall months should take advantage of the service to secure warning in advance of a sudden rainstorm or fall in temperature.

Specifications usually contain a clause covering work done when the temperature is, or there is probability that it will within 24 hrs. drop to, 35° F. or below, in which case the water and aggregates are required to be heated and precautions taken to protect the work from freezing for at least ten days. This clause is provided to cover work done in the late fall when the temperature remains below about 45° or 50° F., or seldom reaches these figures, and when freezing temperatures occur or are likely to occur each night, and when freezing temperatures may at any time continue for several days. Under these conditions this clause should be rigidly enforced. Except where absolutely necessary or desirable to place a short strip or section to complete a contract, the laying of concrete pavement when temperature is 35° F., or less, should be discouraged. It will be cheaper in the long run for the contractor to go to the slightly increased expense of heating water and aggregates rather than be compelled later on to remove and replace pavement damaged by freezing. Even slight freezing of concrete will cause the surface of the pavement to scale off and make it unsightly. Heating of the water and aggregates will permit depositing the concrete at a temperature of from 60° to 70° F., or even higher. This initial amount of heat in the concrete, with that developed in the early stages of hardening, gives the concrete a favorable start, and it is remarkable what such a supply of heat at the beginning will accomplish.

In no case should concrete be deposited upon a frozen sub-grade.

When a hard freeze is to be expected, the best protection is to cover the day's work with at least 3″ of straw or other similar material and then cover with canvas. The canvas should be weighted down to prevent the wind displacing or getting under the canvas. Canvas affords more protection than an earth covering, but if the temperature is mild enough the next day the canvas can be removed and an earth covering placed over the straw. Care will have to be taken at all times to see that there are no spots only partly covered. After 10 das. of favorable weather the covering may be removed.

Whenever practicable, the straw may be omitted and steam turned under the canvas. The night watchman can keep up steam in the mixer boiler for this purpose. The next day, if weather permits, the canvas can be used to cover up the new work and that laid the day before can be covered with straw and earth.

Great care should be exercised in throwing the pavement open to traffic. The length of time necessary to keep the pavement closed to traffic will depend entirely upon weather conditions. In warm weather the pavement should be kept closed to traffic for at least 14 das. and preferably for 3 wks. When the conditions are such that the temperature of concrete is less than 50° F. when placed, hardening takes place very slowly. The hardening will take place in direct proportion to the amount of heat present, and takes place very slowly at a temperature of 35° F. or below.

When a concrete pavement has been laid in the late fall, it is sometimes difficult to determine when it will be safe to throw the road open to traffic. In rare cases it may be necessary, owing to peculiar local conditions, to open the road or street to traffic before it is absolutely safe to do so. Under such conditions if about 3″ of straw is placed on the pavement and this covered with several inches of earth, the surface of the pavement will be protected sufficiently against abrasion to allow the opening of the road sooner than could be safely done without such protection. This cover will, however, not minimize the danger of damage to the pavement by heavy loads, which will tend to crack pavement that has not developed its full strength. Concrete roads have been utterly ruined by opening to traffic too soon. Few people realize how slowly concrete hardens under unfavorable conditions, which will undoubtedly prevail on some jobs before the work is finished. All those in charge of concrete pavement work should have the necessity of adhering to the foregoing cold weather precautions strongly impressed upon them.

Points emphasized not only in this report but in the discussion which followed had to do with the consistency of the mixture and the bad results which follow a segregation of the aggregate when placed on the road. It was emphasized in the discussion that if stone settled in one place and mortar in another the road may be struck off evenly when gone over with a strikeboard and yet be full of small depressions due to uneven settlement of the different materials. It was also pointed out that there is considerable value in checking up the work of the finishers by laying a straightedge on the pavement after the finishers think that they are through with their work.

Ira O. Baker raised a question as to the use of a dry mixture of sand and cement put onto the surface after the concrete is placed, to take up the excess moisture which gives so much trouble in getting the proper road surface. This matter was taken up in detail in a discussion by T. H. Johnson,[6] where about 1,000,000 yds. of concrete paving had been put down. Mr. Johnson explained that the methods in use in Sioux City are quite unorthodox and that he fully anticipated criticism of the methods used, yet he said that the pavements were there to show the results obtained and that in roads 4 yrs. and 5 yrs. old there has been practically no wear on the surface.

Committee 13—Construction of Shoulders and Curbs

Chairman, A. N. Johnson;[1] A. W. Dean,[2] A. B. Fletcher,[3] Charles E. Russell,[4] Edward M. Laing[5]

The Committee on Construction of Shoulders and Curbs recommends that where traffic conditions are such as to make it expedient to build one-track roads only, not exceeding 10′ in width, shoulders should be constructed of gravel or macadam to a width of 6′ on each side. This presupposes that one vehicle is to remain entirely on the roadway while the other vehicle turns off and it also assumes that this is to be done without great reduction of speed on the part of either vehicle. Assuming, however, that the condition under which one vehicle would expect to keep the road and the other take the side, this would be in the case of a heavily loaded vehicle passing a light one. In such a case the heavily loaded vehicle would necessarily be going at low speed and the lighter vehicle would slow up in turning onto the shoulder so that a maximum width is not absolutely required. If two 6-ft. shoulders were to be constructed it would not be economical, as such shoulders could not be constructed at much less cost than to increase the width of concrete to 16′ at the outset. The final recommendation of the committee, therefore, in the case of one-truck road is that 4-ft. macadam or gravel shoulders be built. The shoulders not to be constructed until the concrete has had full opportunity to harden and they are then to be built 7″ thick as measured loose and when finished the shoulders should, if anything, be slightly above the concrete in order to facilitate in turning from the shoulder onto the concrete.

For two-track roads, that is, for roads on which the concrete is at least 16′ wide, the committee finds that it will not be necessary to provide shoulders for traffic purposes but rather for occasional turning out. In this case the shoulders may be constructed of earth material, excluding all vegetable or other matter likely to decay. The slope of the shoulder to the gutter should be continuous, and deep open ditches should not be constructed. The slope of the shoulders for 2′ or 3′ out from the concrete should be but slightly greater than of the concrete and then should decrease gradually as the gutter is approached. The committee further recommends that the shoulder be sown with grass and kept mowed. This will prevent wash.

The construction of shoulders on one-track roads having a grade of 5% and over is an entirely different problem due to the wash which is bound to occur on such grades. The construction which the committee recommends for use on grades of 5% and over in cuts is to do away with the shoulders and gutters and increase the width of the concrete to 15′ or 16′ and to use curbs, allowing the water in excessive rainfalls to use the entire road as a gutter. The width of the cut in this instance would therefore be 16′, plus the width of the curb. It is recommended that the curb be given a slope of about 35° on the side facing the road so that the total width will be about 20′ or a total minimum width of cut of 17′ 8″. The committee believes that a road constructed in this manner will offer as great facility to traffic as though made with shoulders and gutters and occupying a cut 26′ wide. Under favorable conditions it is believed that the cost of constructing the extra 6′ of concrete and curbs would not be more than 25% greater than the construction of macadam shoulders with paved gutters and the cost of maintenance is greatly reduced.

The construction on fills, however, should be with curbs having a vertical face. On fills that are more than 5′ or 6′ deep or where sufficient material cannot readily be obtained to widen the fills to 26′ on top with broad slopes it is recommended that the concrete pavement be widened to 16′ or 18′ and vertical curb 6″ high be constructed. The curb answers a double purpose in preventing erosion of the fill by storm water which falls upon the pavement proper and, second, offers a very considerable protection to traffic. The fills should be at least 6′ wider than the pavement but in no case less than 22′ wide on top. This will give sufficient room to set a strong guard fence outside of the line of the curb.

On two-track roads with grades of 5% and over on cuts it is recommended that gutters and shoulders be done away with and a curb be constructed allowing the whole road surface to take extra storm water. The recommended width is 16′ at least and preferably 18′. On fills the construction recommended is like that for the construction of shoulders for single track road on fills. If the fill is on a grade the curb should be provided. If the fill is over 5′ or 6′ deep and cannot be made wide, vertical curbs are recommended.

A principle of reinforced concrete is now apparently being used in connection with the manufacture of the latest and most up-to-date type of German aeroplane. Wings composed of "slabs of synthetic resin, reinforced with wire mesh, and metallic rods made of alloy," to quote a daily paper of wide circulation, have been tested and found to be not only of great tensile strength, but practically "invisible." Reinforcement of this type is a novelty, which will probably appeal to the firms which manufacture reinforcing fabric.

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[6] City Engr., Sioux City, Ia. Mr. Johnson's discussion was presented practically in full in the Mar., 1916, issue of Concrete, p. 125

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[2] Chf. Engr., Mass. Highway Comm., Boston

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[4] Co. Supt. of Highways, Lake County, Waukegan, Ill.

[5] Pres., Edward M. Laing Co., Contrs., Highland Park, Ill.

A Review of Various Experiences in Waterproofing

By R. B. Sleight[1]

This discussion of waterproofing methods is not based upon original experimental research by the writer in any way but upon a general study of the available data and performances of existing pieces of work as given and described by a few investigators and authors of the past 10 years, and upon some personal observation. This will take up waterproofing primarily, and dampproofing only in as far as the processes are identical.

It will be well to state the generally accepted causes of permeability in concrete:

(a) The lack of proper provision for settling and expansion, designed to prevent cracks; and the lack of adequate drainage during construction.

(b) The use of improperly graded aggregate and lean mixtures.

(c) Defective workmanship in form building, mixing and placing. The last is probably the most prevalent cause of leaky concrete structures.

Methods used to produce waterproof concrete may be placed in the following three general classes:

1. By the membrane method an external treatment of hardened concrete to produce watertightness.
2. By the integral method, involving addition of waterproofing ingredients to the concrete while mixing, i. e., the use of some substance other than the mixture of cement, sand and stone with water.
3. By proper selection, grading and proportioning of the aggregate.

Each method has advantages and will be discussed separately.

EXTERNAL TREATMENT OF THE CONCRETE STRUCTURE

The membrane method consists either of using a coating that will prevent the water from coming in contact with the concrete, or treating the surface in a manner such as effectively to seal the surface.

This method is most widely used as a corrective measure, for repairing cracks appearing on or covering the surfaces of tanks and reservoirs that after trial have proved defective as to waterproof requirements. However, the treatment is sometimes used as soon as the concrete has set. The most common successful method is the use of tarred paper or felt placed in layers in hot pitch or asphalt on the surface and protected with a suitable covering such as an additional layer of concrete or a brick wall.

A treatment of the hardened concrete to close the pores at the surface is common, its cost is not excessive and in many instances is the most desirable one to be advised. For work in which cracks have to be contended with or in which uniform settlement may occur asphalt probably forms one of the most effective coatings. This, applied hot to the clean concrete, should be of such a quality that the heat of the summer sun will not cause it to flow and it should, if in a cold climate, not crack to cause failure at the low temperatures to which it will be subjected. Asphalt coating can be used only where its color will not be objectionable.

The use of a neat cement wash coating applied with brush has been found effective for low heads up to about 10′. It is easily applied and in many cases is to be recommended. Its use in concrete lined channels and conduits not only increases the watertightness but also reduces the coefficient of friction. The objection is that under changes of temperature and moisture conditions it is apt sometimes to crack and peel off, especially if the surface has not been well prepared and cleaned before application.

On small structures, where the cost is not of great importance, the use of various paints and proprietary compounds may be found advantageous, particularly so when it is desired to combine coloring with waterproofing.

The old Sylvester method or modifications of this have been used with more or less success when applied to concrete as a waterproofing method. This consists of alternately washing the structure with a hard or a soft soap solution and then with a solution of alum. There are recommended[2] for the soap solution, 2.2 lbs. of soap per gal. of water and for the alum solution 1 lb. of alum per gal. of water. Aluminum sulphate substituted for the alum is cheaper and equally effective. The concrete surface is given from one pair to eight pairs of coats, as is necessary. Impermeability under heads of 100′ are claimed for the alum and soap wash.

These methods represent approved practice for hardened concrete surfaces to obtain waterproof properties and the selection of the one to be used will depend upon the character of the work and the allowable cost.

THE ADDITION OF WATERPROOFING INGREDIENTS

The use of various ingredients incorporated into the mix has been the subject of considerable investigation and these materials have been extensively employed in practice. The substances used may be classified as water-repellant or oil-like materials, and inert, void-filling substances as clay, or another division might be made in separating mechanical action and chemical action. This last classification will not be discussed in this article. The principal ingredients in use are: proprietary compounds and preparations which are protected by patent, oils, clay, puzzolan, cement, hydrated lime and a mixture of soap and alum. Numerous tests have been made in the use of these substances to determine their value in producing impermeability and their effect upon the strength of the concrete.

Commercial compounds under test have shown as a rule that with proper care in their use the concrete may be made reasonably waterproof. In many recorded experiments[3] there is shown a reduction in the strength, both in tension and compression, of the concrete in which these ingredients have been used. A few cases are reported where practical difficulties in placing have not allowed their use, particularly because of foaming and not mixing. As a rule, considerable care is necessary in the employment of any proprietary compound to produce the best results.

The selection of oils used for waterproofing concrete must be made with considerable care.[4] Experiments made on the high asphalt oils of California have shown that these are not effective as waterproofing agents and cause a decrease in strength. This lack of waterproofing quality is probably due to the fact that these high mineral oils do not emulsify and mix with the concrete. It was shown that with from 5% to 15% of oil the product was more permeable (pressures of 20 lbs. to 60 lbs. per sq. in.), tensile strength was less and compressive strength was less than for plain mortar.

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[1] Asst. Irrigation Engr., U. S. Dept. Agriculture, Denver, Col.

[2] Prof. I. O. Baker

[3] Bur. of Standards, Edward Weggman, at Husum in Germany, and others

[4] Taylor and Sanbourn

Oils coming under the following specifications[5] have been found much more desirable in producing imperviousness and in their effect upon strength:

1. Oil to have a specific gravity not less than .930 and not greater than .940 at 25° C.
2. It shall be at least 99.9% soluble in carbon disulphide at air temperature.
3. It shall contain not less than 1.5% and not more than 2.5% of bitumen insoluble in .86° B. paraffin naphtha.
4. It shall yield not less than 2.5% nor more than 4.0% of residual coke.
5. When 240 cc. of oil is heated in an Engler viscosimeter to 50° C. and maintained at that temperature for at least 3 min. the first 100 cc. that flows out shall show a viscosity of not less than 40 nor more than 45.
6. When 20 grams of oil is heated for 5 hrs. in a cylindrical tin dish, 2½″ in diam. by 1″ high at a constant temperature of 163° C. the loss in weight shall not exceed 2%.

These specifications exclude the high asphaltum oils of California.

The samples used in experiment and coming under the above specifications were combined with a 1:3:6 concrete. It was shown that while the strength was decreased somewhat by the addition of 10% of oil the mortar was absolutely waterproof for pressures up to 40 lbs. per sq. in.

The possible use of clay as a waterproofing agent when mixed wiht the cement, sand and stone has been investigated to some extent. Reliable data[6] show that the addition of clay decreases permeability considerably and increases strength to a slight degree. Its use as balanced against the addition of extra cement to accomplish the same result will in all cases have to be based upon a careful consideration and comparison of costs. Both plain blue brick clay and pure white Georgia clay show about the same properties as far as producing waterproofing is concerned.

Hydrated lime is employed effectively but can probably be used most economically for the lower heads only. A 1:3:6 concrete requires a weight of hydrated lime equal to 20% of the weight of the cement to be efficiently waterproofed for high heads. The same comparison of the cost of hydrated lime required with the cost of excess cement to produce an equivalent waterproofing effect must be made here as in the use of clay.

Pozzolan cement was found[7] to be less effective than hydrated lime in producing impermeability. It, however, finds use in structures exposed to the action of sea water.

A simple method showing considerable promise, which has not been used to a large extent, is that of the soap and alum mixture. The recommended proportions for this are alum 1 part and hard soap 2 parts, both by weight; or, a cheaper and equally effective substitute is aluminum sulphate, 1 part and hard soap 3 parts by weight. Where this was used in sufficient quantity to fill 5% of the voids, percolation was reduced to ⅓ of that of untreated mortar. No absolutely impermeable concrete was produced. The strength of the product was reduced somewhat from that of the untreated concrete.

Among the other ingredients which have been tried with more or less success may be mentioned fats, soft soap, lye, soap and alum mixed, pitch, resin, wax and paraffin. None of these is of particular importance alone, although many of the proprietary compounds contain these substances in mixture or in chemical combination.

PROPER GRADING AND AN EXCESS OF CEMENT

The method that combines increased strength with imperviousness in concrete is that of the proper grading of the materials, cement, sand and stone, combined with an excess of cement. The same general statements can be made regarding watertightness as regarding strength: with the same percentages of cement the mixtures giving the most dense concrete are the most watertight, and with the same density and different percentages of cement the watertightness decreases with increased quantities of cement. This method has been used in many important structures. Notably among these are the Catskill Aqueduct and the Los Angeles Aqueduct tunnel. This method was employed after considerable study and some experimentation with other methods. The best of results were obtained. The mixture used was a 1:2:4 concrete. Tests made in connection with the Catskill structure led to the conclusions: [8]"with reasonable care in mixing and placing concrete, and with sufficient excess cement, a concrete can be had which will be practically watertight gaainst hydrostatic heads of several hundred feet." (In this 37.1% in excess of voids was used, amounting to 1.70 bbls. per cu. yd. of concrete.) In the test of the tunnel a maximum head of 312 lbs. per sq. in. was applied with practically no leakage. Many other structures bear out these conclusions.

In experiments of the same nature by Fuller and Thompson[9] conclusions were reached as follows:

1. The rate of flow is less as the percentage of cement increases, and in a much larger inverse ratio. (The extreme case is this: a concrete with 8% of cement allowed the passage of 273 grams of water per min. at 80 lbs. pressure, while with 15% of cement the concrete allowed only 12 grams per min. to pass.)
2. The rate of leakage through concrete decreases materially with age.
3. Permeability increases about uniformly with increase of pressure.
4. The rate of flow through concrete increases as thickness decreases, but in a much larger inverse ratio.

The objection to the rich mixture is that it is apt to check and crack. Unless well protected by steel and in other ways from rapid changes in weather and temperature conditions, its use would not seem advisable for all structures, even if cost estimates were in its favor.

After analysis of several methods it is not possible to give definite conclusions and directions as to what means of waterproofing should be used. Each of the particular systems described is applicable under certain conditions, and combinations are often desirable and advisable. It can be stated definitely, however, that bad workmanship cannot be completely counteracted by the addition of waterproofing compounds or ingredients.

A combination of external coating and void-filling materials is suggested where increased strength is not a necessity. The addition of excess cement in cases in which cracks are not apt to appear or in which the concrete has no opportunity to dry out, is undoubtedly advisable. In this watertightness is combined with increased strength. Many of the patented compounds are commendable and serve the purpose for which they are intended, while others are largely valuable as money-making propositions for the manufacturer. Very few of them add to, and many are injurious to the strength of the concrete, and have no permanent effect upon permeability. In view of this their use is not advised unless reliable data are at hand showing the action of the particular brand under a long-time test.

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[5] Logan Waller Page, Bul. 230, U. S. Dept. of Agriculture

[6] James L. Davis and others

[7] Prof. I. O. Baker, *Masonry Construction and Technograph*

[8] C. R. Hulsart

[9] *Trans*, A. S. C. E., Vol. 59

With correctly graded aggregate, enough water to produce a consistency such that but little tamping is required (not an excess of water), and with good workmanship, reasonably impermeable concrete may be obtained with quite lean mixtures. In all concrete construction the prime requisite is good workmanship.

A Time-Saving Table For Plasterers

A method that will save time and mistakes in figuring plastering work is contributed by P. H. Bosworth.[1]

"Put down in two columns the lengths of the two sides of the rooms to be figured that have the same ceiling height. Add each column and multiply the totals by 2 for the four sides of the rooms; then multiply each by the ceiling height; this gives the sq. ft. in walls.

Extend a third column from the other two by multiplying the two sides of each room together which, when added, gives the sq. ft. in the ceiling. Add the three totals together and divide by nine for the sq. yds. in the job. Rooms having wainscoting and high base are figured separately."

Mr. Bosworth has compiled a ready reference table, which is worth preserving.

Bureau of Standards Reopens Investigation of Waterproofing

Announcement is made that the U. S. Bur. of Standards is to undertake a continuation of the tests of dampproofing and waterproofing materials, as reported in Technologic Paper No. 3 dated Aug. 22, 1911, entitled, *Tests of the Absorptive and Permeable Properties of Portland Cement Mortars and Concrete, together with Tests of Damp-proofing and Waterproofing Compounds and Materials.*

Waterproofing manufacturers have been very much dissatisfied with the findings of the Bureau's investigators, in Technologic Paper No. 3. It will be interesting here to quote from the summary of the report as follows:

> Portland cement mortar and concrete can be made practically watertight or impermeable to any hydrostatic head up to 40′ without the use of any of the so-called "integral" waterproofing materials, but in order to obtain such impermeable mortar or concrete, considerable care should be exercised in selecting good materials as aggregate, and proportioning them in such a manner as to obtain a dense mixture. The consistency of the mixture should be wet enough so that it can be puddled, the particles flowing into position without tamping. The mixture should be well spaded against the form in which it is placed so as to avoid the formation of pockets on the surface.
>
> The addition of so-called "integral" waterproofing compounds will not compensate for lean mixtures, nor for poor materials, nor for poor workmanship in the fabrication of the concrete, since in practice the inert integral compounds (acting simply as void filler material) are added in such small quantities as to have very little or no effect on the permeability of the concrete. If the same care be taken to make the concrete impermeable without the addition of waterproofing materials as is ordinarily taken when waterproofing materials are added, an impermeable concrete can be obtained.

In view of the fact that numerous engineers continue to use integral waterproofing material with apparent satisfaction, in spite of the report of the Bur. of Standards in Technologic Paper No. 3, the Bureau has decided to extend the investigation made several years ago when a great many of the waterproofing compounds which were available at that time were looked into. The new investigation, or rather the continued investigation, contemplates the construction of tanks of commercial size "with and without waterproofing." The tanks are to be built by contract under normal field conditions. Investigation also contemplates a field survey on the experiences of various engineers and contractors with integral waterproofing materials. The detailed program of investigations has not yet been completed.

TABLE FOR MEASURING PLASTERERS' WORK QUICKLY AND ACCURATELY[2]

Size of Rms.	Perimeter of Rms.	HEIGHT OF CEILINGS 7′ 0″	 7′ 6″	 8′ 0″	 8′ 6″	 9′ 0″	 9′ 6″	 10′ 0″	 10′ 6″	 11′ 0″	 12′ 0″	 13′ 0″	 14′ ″
		yds. ft.	yds. ft.	yds. ft.	yds. ft.	yds. ft.	yds. ft.	yds. ft.	yds. ft.	yds. ft.	yds. ft.	yds. ft.	yds. ft.
2x 4	12	10 2	10 8	11 5	12 2	12 8	13 5	14 2	14 8	15 5	16 8	18 2	19 5
3x 4	14	12 2	12	13 7	14 5	15 3	16 1	16 8	17 6	18 4	20 –	21 5	23 1
3x 5	16	14 1	15	15 8	16 7	17 6	18 5	19 4	20 3	21 2	23 –	24 7	26 5
4x 5	18	16 2	17 2	18 2	19 2	20 2	21 2	22 2	23 2	24 2	26 2	28 2	30 2
5x 5	20	18 3	19 4	19 5	21 6	22 7	23 8	25 –	26 1	27 2	29 4	31 6	33 8
5x 6	22	20 4	21 6	22 8	24 1	25 3	26 5	27 7	29 –	30 2	32 6	35 1	37 5
6x 6	24	22 6	24	25 3	26 6	28 –	29 3	30 6	32 –	33 3	36 –	38 6	41 3
6x 7	26	24 8	26 3	27 7	29 2	30 6	32 1	33 5	35 –	36 4	39 3	42 2	45 1
7x 7	28	27 1	28 6	30 2	31 7	33 3	34 8	36 4	38 –	39 5	42 6	45 7	48 8
7x 8	30	29 5	31 2	32 8.	34 5	36 2	37 8	39 5	41 2	42 8	46 2	49 5	52 8
8x 8	32	32 2	34 0	35 7	32 5	39 3	41 1	42 8	44 6	46 4	50 –	53 5	57 1
8x 9	34	34 4	36 3	38 2	40 1	42 –	43 8	45 7	47 6	49 5	53 3	57 1	60 8
9x 9	36	36 8	38 8	40 8	44 8	46 8	46 8	49 8	50 8	52 8	56 8	60 8	64 8
9x10	38	39 5	41 5	43 7	45 8	48 –	50 1	52 2	54 3	56 4	60 6	64 8	69 1
10x10	40	42 2	44 4	46 6	48 8	51 8	53 3	55 5	57 7	60 –	64 4	68 8	73 3
10x11	42	44 8	47 2	49 5	51 8	54 2	56 5	58 8	61 2	63 5	68 2	72 8	77 5
11x11	44	47 6	51	52 5	55 –	57 4	59 8	62 2	64 7	67 2	72 1	77 –	81 8
11x12	46	50 4	53	55 5	58 1	60 6	64 2	65 7	58 3	70 8	76 –	81 1	86 2
12x12	48	53 3	56	58 6	61 4	64 –	66 6	69 8	72 –	74 6	80 –	85 3	90 6
12x13	50	56 2	59	61 7	64 5	67 3	70 1	72 8	75 6	78 4	84 –	89 5	95 1
13x13	52	59 2	62 1	65 –	67 8	70 7	73 6	76 5	79 2	82 3	88 1	93 8	99 6
13x14	54	62 2	65 2	68 2	71 –	74 2	77 –	80 2	83 2	86 2	92 2	98 2	104 2
14x14	56	65 3	68 4	71 5	74 6	77 7	80 1	84 –	87 1	90 2	96 4	102 6	108 8
14x15	58	68 4	71 6	74 8	77 8	81 3	84 5	87 7	91 –	94 2	100 6	107 1	113 5
15x15	60	71 6	75	78 3	81 6	85 –	88 3	91 6	95 –	98 3	105 –	111 6	118 3
15x16	62	74 8	78 3	81 7	85 2	88 6	92 1	95 5	99 3	102 4	109 3	116 2	123 1
16x16	64	78 2	81 7	85 3	88 8	92 4	96 –	99 5	103 1	106 6	113 7	120 8	128 –
16x17	66	81 5	85 2	88 8	92 7	96 2	99 8	103 5	107 2	110 8	118 2	125 5	132 8
17x17	68	85 –	88 7	92 5	96 3	100 1	103 8	107 6	111 4	115 2	122 7	130 3	137 8
17x18	70	88 4	92 3	96 2	100 1	104 –	107 8	111 7	115 6	119 5	127 3	135 1	142 8
18x18	72	92	96 –	100 –	104 –	108 –	112 –	116 –	120 –	124 –	132 –	140 –	148 –
18x19	74	95 5	99 6	103 7	107 8	112 –	116 1	120 2	124 3	128 4	136 6	144 8	153 1
19x19	76	99 2	103 4	107 6	111 8	116 1	120 3	124 5	128 7	133 –	141 4	148 8	158 3
19x20	78	102 8	107 2	111 5	115 8	120 2	124 5	128 8	133 2	137 5	146 2	154 5	163 5
20x20	80	106 6	111 1	115 5	120 –	124 4	128 8	133 3	137 7	142 2	151 1	160 –	168 8
20x21	82	110 4	115 –	119 5	124 1	128 6	133 2	137 7	142 3	146 8	156 –	165 1	174 2
21x21	84	114 3	119 –	123 6	128 3	133	137 1	142 3	147 –	151 6	161 –	170 3	179 6
21x22	86	118 2	123 –	127 7	132 5	137 3	142 1	146 8	151 6	156 4	166 –	175 5	185 2
22x22	88	122 2	127 1	132 –	136 8	141 7	146 6	151 5	156 4	161 3	171 1	180 8	190 6
22x23	90	126 2	131 2	136 2	141 2	146 –	151 2	156 2	161 2	166 2	176 2	186 2	196 2
23x23	92	130 3	135 4	140 5	145 6	150 7	155 8	161 –	165 1	171 2	181 4	191 6	201 8
23x24	94	134 4	139 6	144 8	150 1	155 3	160 5	165 7	171 –	176 2	186 6	197 1	207 5
24x24	96	139 6	144 –	149 3	154 6	160 –	165 3	170 6	176 –	181 3	192 –	202 6	213 3
24x25	98	142 8	148 3	153 7	159 2	164 6	170 1	175 5	181 –	186 4	197 3	208 2	219 1
25x25	100	147 2	152 7	158 3	163 8	169 4	175 –	180 5	186 1	191 6	202 7	213 8	225 –

EXPLANATION OF TABLE

First column—size of rooms—is for rooms that are square, or nearly square, up to 25′ each way. Height of ceilings, 7′ to 14′.

Second column—lin. ft. around rooms—is for any shaped room where the size of the sides, or the combined sides, do not exceed 100.

Example—To find the yards of plastering in a room 16′ x 16′, ceilings 10′ 0″ high, run down first column—size of rooms—as the room in this case is square, to line 27, which gives the 16 x 16 room. Follow this line across to the 10′ 0″ ceiling column, where the answer is 99 yds. 5 ft.

Again—To find the yards of plastering in a room 16′ x 20′, ceilings 10′ 6″ high, the combined sides, twice 16 and 20 makes the sum 72; run down the second column to line 31, which gives the lin. ft. around rooms as 72. Follow this line across to the 10′ 6″ ceiling column, where the answer is 120 yds.

Subdivide irregular shaped rooms into regular shaped units, proceed as above, make necessary allowances for duplicating sides.

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[1] Gen. Contr., San Francisco

[2] Copyright, 1913, by P. H. Bosworth.

Design and Structural Details of Concrete Lining for Irrigation Canals[1]

In the U. S., irrigation canals are for the most part excavated in earth, and, except in a few cases, a large percentage of the water, estimated at 40% of the amount taken in at the heads of the main canals, is lost by absorption and penetration along the routes. But allowing for water later collected by lower conduits, the amount that is wholly lost may be reduced to 25%. Loss of water in irrigation canals is due to several causes but by far the greatest loss is due to seepage. Prevention of seepage loss is best accomplished by lining the canals and of all linings tried concrete is the most satisfactory and is being most used.

CARRYING CAPACITIES OF CONCRETE-LINED CANALS

Data pertaining to the carrying capacities of 18 concrete-lined canals were assembled and summarized.

Perhaps the most important conclusion to be drawn from the 76 measurements of the 18 canals summarized is that the so-called coefficient of friction n is on an average larger than has usually been assumed by engineers. The results show that only in rare cases, where conditions are more or less nearly ideal, is one justified in assuming a value as low as 0.012 for n. The Ridenbaugh canal of the Nampa and Meridian irrigation district of Idaho belongs to this class. The flow in this concrete-lined canal has been measured by at least five engineers and their average result as regards the value of n is a trifle below 0.012. In the results assembled, one also finds a value of n as high as 0.0197 and five others greater than 0.018. Again, in the concrete-lined canals of southern California a coating consisting of a vegetable and mineral accumulatios was found adhering to the perimeters. The effect of this coating on the flow of water is seen in the high coefficient of friction for these channels.

The following approximated values for n may serve as a guide to those who are required to estimate, prior to construction and operation, the discharge of lined canals.

I. $n = 0.012$ for concrete-lined canals having a smooth sidewalk finish, clean bottom, no moss, uniform cross-section, well formed joints, long tangents, flat spiral curves, no perceptible undulations on the surface of the water, and in general the best construction and the best conditions obtainable in practice.

II. $n = 0.013$ for concrete-lined canals having conditions slightly better than those of Type III and not so good as those of Type I.

III. $n = 0.014$ for concrete-lined canals having an unplastered or rough troweled surface, clean bottom, uniform cross-section, well formed joints, medium curvature, no spirals, slight surface undulations, no aquatic vegetation, and in general good construction and favorable conditions.

IV. $n = 0.015$ for concrete-lined canals having conditions similar to those of Type III, but with greater curvature and some debris or other retarding influences.

V. $n = 0.016$ for concrete-lined canals of average workmanship and medium conditions, having a rough surface, imperfect joints, and sharp curves; also for canals of smooth lining and good workmanship, but having one or more unfavorable conditions, such as sand and gravel in the bottom or projecting joints which decrease the velocity of water.

VI. $n = 0.017$ for concrete-lined canals roughly coated, but otherwise in medium condition.

VII. $n = 0.018$ for concrete-lined canals coated as in Type VI and having the bottom more or less covered with sand and gravel, or else a clean bottom but poor alignment, irregular cross-section, broken gradient, or the like.

ECONOMY OF CONCRETE LINING

In determining the economy of concrete lining for a given canal, one has to consider and compare the cost and benefits of such work. Itemized statements of the cost of concrete lining for various canals are given in another part of this report. The principal benefits to be derived from lining are briefly discussed under the following heads:

(1) *Seepage Water and Its Value.*—The possible saving in seepage losses by lining can be readily determined for canals already in use, and the portions in which this is important can be located by measurements of the discharge. In some cases the loss in short distances may be sufficient to make the lining of these desirable, although it would not be practicable to line the canal as a whole.

In nearly every irrigated district of the West water which can be saved through the prevention of seepage has a value. As the demand for water increases the value of any saving will also increase until methods of canal lining at present too expensive to be considered may become practicable. The value of the water which may be saved varies widely in the different portions of the country. On the larger systems now being constructed, water rights are being sold for from \$25 to \$50 per acre, and in some cases for even higher prices.

Based on the final estimated cost and acreage included, the average estimated cost per acre Jul. 1, 1910, was \$48.14 for the U. S. Reclamation Service projects and \$21.75 for the Carey Act projects. The duty of water delivered under these rights is also variable and will probably average 1 sec.-ft. to 100 acres. Inasmuch as any saving in canal seepage can be delivered to the user with small additional loss, each 0.01 sec.-ft. saved should make it possible to serve another acre. The additional expense required for such irrigation would be for the lateral system only, as the storage and diversion works would not be affected. On this basis each sec.-ft. of water which can be saved should have a value of from \$2,500 to \$5,000. Allowing \$750 for the additional cost of the distributing system leaves \$3,000 as a general average for the value of each sec.-ft. saved by lining.

(2) *Increase in Carrying Capacity.*—The volume carried by a canal in earth is as a rule much less than that carried by a concrete-lined canal of the same dimensions and grade. This is due to

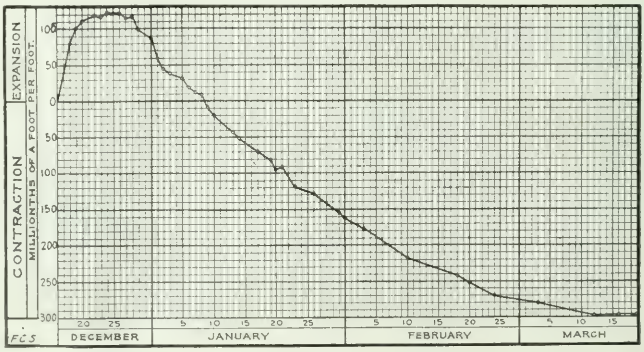

FIG. 1—CURVES SHOWING EXPANSION AND CONTRACTION OF CONCRETE FROM ACTUAL MEASUREMENTS MADE ON A 10-FT. SLAB

the smoother perimeter of the latter, and its greater uniformity in cross-section, alignment, and grade. The discharge of a typical canal in earth having a mean velocity of 2.5 ft. per sec. and a coefficient of friction (n in Kutter's formula) of 0.0225, may be increased from 25% to 80% by lining with concrete. A gain of of 25% in the volume carried is readily obtained as the result of lining, but to secure a gain of 80% involves the construction of first-class lining and conditions favorable to the maximum discharge of water in such channels.

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[1] Abstract from Bulletin No. 126 of the U. S. Dept. of Agriculture on "Concrete Lining as Applied to Irrigation Canals," by Samuel Fortier, Chf. of Irrigation Investigations. This bulletin treats of the subject of concrete lining for irrigation canals from the standpoints of economy, design and construction. It is intended for the use of irrigation engineers and the managers and superintendents of irrigation systems.

(3) *Reduction of Charge for Operation and Maintenance.*—On many systems, particularly where the canal follows a side hill, much difficulty is encountered from breaks on the lower bank when the canal is crowded to its full capacity or when an opening may be made by a gopher or other burrowing animal. A concrete lining should prevent such breaks except in cases where the water overtops the banks due to stoppage or other causes. Faulty location of the canal and weak places developing later can very often be largely corrected by a good concrete lining. Where the original grade is such that scour occurs, or where excessive curvature causes cutting of the sides, a similar remedy may be used. Maintenance charges also will be materially reduced by the lessening of weed growth and the prevention of the shifting of the channel through scouring. In some systems the fall of the country is too great to be taken up by the grade of the canal and many drops are required which may form a considerable proportion of the cost and necessitate high maintenance expenses. The use of a concrete lining frequetly permits a sufficiently high grade to be used so that no drops are needed, the saving in these structures paying part of the cost of the lining.

(4) *Insurance Against Damage to Crops.*—As the losses from the lack of water at critical times during the irrigation season are often much greater than the actual cost of repairs, a portion of the cost of any canal lining may be considered as an insurance against such accidents. An instance of this occurred on the Turlock canal, of Cal., in 1910, when a break thought to have been due to a gopher hole caused 1,000′ of the main canal on a steep side hill to be washed out. The canal was out of service for 6 wks. at the time when water was most needed for the crops. The actual cost of repairs was $20,000, but the estimated damage to crops was $1,000,000.

GRADES FOR LINED CANALS

In deciding upon suitable grades, cross-sections and alignment for lined canals, one has to take into account the two types of canals which are lined. One of these is represented by the canal in operation designed for earth, the other by the new canal designed for concrete lining.

The grade which is suitable for a canal in earth is not the most economical grade for the same canal when lined with concrete. It is not, however, feasible to make any material change in the grade of an old canal preparatory to lining it. The irregularities can and should be removed so as to secure a uniform gradient, but more than this can not be done without changing the location.

The discussion of suitable grades must therefore be confined in this report to new canals intended to be lined before carrying any large percentage of their maximum capacity. Disregarding all other features and considering only the most economical method of conveying water, the steep grade with its correspondingly high mean velocity is best. The fact is now fairly well established that water can pass over a concrete surface at a high velocity without injurious effects. It is only when fast-flowing water strikes against concrete or is obstructed by it that damage is likely to result. A. P. Davis, chf. engr. of the Reclamation Service, cites a case in which a concrete chute on the south canal of the Uncompahgre project, discharging 300 cu. ft. per sec. at a velocity of over 20 ft. per sec. for 1 yr., not only showed no perceptible wear, but it had acquired a growth of slimy moss over the concrete surface subject to this velocity.

In the summer of 1913 Justin T. Kingdon, of this office, made an examination of a concrete chute on the main canal of the Orland project, Orland, Cal. The canal maintains a fairly constant flow throughout the season. It was measured shortly after the observation and found to be discharging 84 sec.-ft. of water which at the bottom of the chute had a velocity of 17′ per sec., and like the south canal of the Uncompahgre project, this concrete showed no wear on its wetted area, and the growth of slimy moss which it had acquired was especially noticeable over that portion of the surface subject to the highest velocity.

It would therefore appear that the permissible velocity in lined canals depends largely on considerations other than damage to the lining. The mention of three of these causes may serve to make this statement clear. Assuming that a concrete-lined canal will successfully withstand velocities up to 20′ per sec., the fall necessary to produce such velocities must be considered since the sacrifice of so much head might entail greater cost than the building of a larger canal on a lighter grade. Again, the extra cost and inconvenience in making suitable turnouts to divert water from such a canal would serve to lessen the advantages gained by having a high velocity. Lastly, pulsations are a common feature in all channels in which the water flows at a high velocity. The water surface consists of irregular waves which travel at various distances apart and an extra height of lining is required to prevent the waves from overtopping it.

It is believed that a mean velocity of between 8′ and 10′ per sec. is about as high as should be adopted in lined canals under ordinary conditions.

ALIGNMENT OF LINED CANALS

In locating a new canal for concrete lining, sharp curves should be avoided if possible. The reduction of curvature in a location over a rough country with steep slopes may increase considerably the amount and the cost of excavation, but this additional expense may be more than compensated by the advantages gained in having flat curves.

In flowing around curves the surface of the water tends to rise on the outer side, due to centrifugal force. The height to which it will rise in any given case will depend on the velocity of the water and the sharpness of the curve. In order to maintain a uniform height of lining above the water surface of the canal, the practice has been to raise the outer lining. In the case of the Tieton main canal of the U. S. Reclamation Service, Yakima project, Wn., on the sharpest curves, having a radius of 57.6′ and a velocity of 9′ per sec., the superelevation amounted to about 1% of the width. The presence of a large number of sharp curves likewise increases the cost of both the earth trimming and the laying of the concrete.

THE EFFECT OF ALKALI ON CONCRETE LINING

In the West are to be found here and there instances of concrete construction having been disintegrated through the action of alkali salts. While some uncertainties remain regarding the exact nature of such action, there seems to be no question that the principal reason for it arises from the reaction between the various alkali salts and the calcium hydroxide of the cement. The new compounds formed have a greater volume than the replaced hydroxide and their formation weakens or destroys the concrete by forcing apart the particles of cement. In order that this action may occur it is necessary for the water containing alkali to percolate into or through the concrete. Under field conditions "these reactions referred to are much retarded if not entirely suspended in most cases, due probably to the carbonization of the lime of the cement near the surface or the formation of an impervious skin or protective coating by saline deposits." It is also doubtless true that "wetting and drying or freezing and thawing will hasten the destruction of the ce-

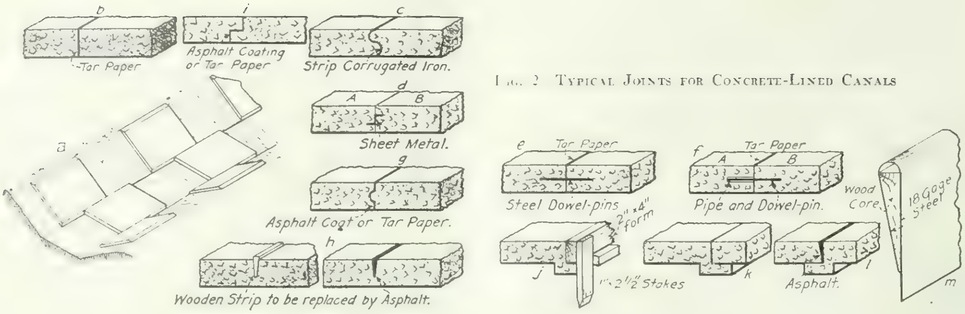

Fig. 2 Typical Joints for Concrete-Lined Canals

ment by extending the cracks already started."

In experiments with oil-mixed Portland cement concrete,[1] the concrete was damp-proofed by the incorporation of semi-asphaltic oil. In hand mixing, the sand, cement and water were first mixed to a mushy consistency, the oil added and mixed until no trace of it was visible on the mortar surface, and then the broken stone or gravel was mixed in. In machine mixing the sand, cement and water were first mixed to a mortar followed by alternate batches of stone and oil which were added and mixed. The proportion of oil used was based on a comparison of its weight to the weight of the cement used in the concrete. The results of tests show that oil-mixed mortar, containing 5% to 10% of oil, is damp-proof as well as waterproof, and indicate that its use may prove desirable in the construction of irrigation canal linings exposed to the action of alkali (Fig. 1).

Good practice in concrete lining construction where alkali must be reckoned with necessitates the following precautions:

(1) Do not use sand, gravel, or water containing alkali.

(2) By the use of proper drainage keep soil waters charged with alkali from coming into contact with the concrete.

(3) Give careful attention to the proper proportioning of materials and use more cement than is needed to fill the voids.

(4) Protect the surface by a thin plaster coat of a dense mortar of granular sand.

(5) Both the concrete and the mortar used for the lining may be dampproofed by the addition of 5% to 10% of semi-asphaltic oil when mixing the materials.

EXPANSION AND CONTRACTION OF CONCRETE

Field Tests at Logan, Utah.—In the summer of 1913 field experiments were conducted by Prof. B. P. Fleming, of the State Univ. of Ia., working under the direction of this office, at Logan, Utah, for the purpose of determining the coefficient of expansion of concrete slabs. An effort was made to secure conditions as nearly as possible like those found for canal linings. It will be noted, however, that the slabs were not tested to find the effect produced by being wet on one side. The variations in length were measured with two micrometer microscopes focused upon lines in the highly polished tops of two steel pins projecting above the surface of the slab, one at each end. This device permitted making direct readings from the micrometer scale, giving measurements to 0.0008 mm. The thermometers used were graduated to 0.10° C. and could be estimated easily to 0.025° C. All measurements of the slab length were direct, and no part of the aparatus was in contact with the slab. The idea of maintaining the latter condition was to prevent in every possible way influences which might affect the expansion of the slab. Except for a roller placed under one end, each slab was lying on ground composed mostly of loose gravel. The slabs were 12" wide, 6" deep, and 11' long. The steel pins inserted vertically in the top were spaced 10' apart, thus leaving 6" length of slab beyond the pin at each end. A wet hand-mixed concrete mixture was used for each slab, numbered 1 and 2, and volumetrically proportioned 1:3:5 and 1:2:4, respectively. Each slab was of rectangular cross-section throughout. The general average coefficient of expansion measured was 0.0000043 for slab 1 and 0.0000042 for slab 2.

Laboratory Tests at the State University of Ia.—In the fall and winter of 1913-14 the experimental work initiated at Logan, Utah, was continued in the laboratory of the State Univ. of Ia. under the same supervision as before. The sand and gravel used were taken from the bed of the Iowa river. This raw material was screened through a 1-in. mesh screen and again through a ¼-in. mesh screen. The material failing to pass the latter screen was considered gravel. The sand was unscreened, but it was fine and clean. Three horizontal slabs were cast with the same dimensions as those made at Logan. The apparatus and equipment were practically the same, except that the laboratory permitted a somewhat careful control of influencing conditions not possible in the open-air work. In addition, a specially devised apparatus permitted the making of observations for change of length within 30 min. after water had been added to the dry materials used in making the concrete. Brass pins with their upper ends highly polished were used instead of steel pins. The methods employed for temperature determination and control were quite satisfactory and it is believed gave results fully as accurate as the investigations warranted. Two slabs of seasoned concrete were used for determining the coefficient of expansion. A third slab was used to determine the influence on change of length due to setting. Each slab was made of hand-mixed concrete, using the materials composing the concrete in the following proportions:

	Number of slab.		
	1	2	3
By volume:			
Cement	1	1	1
Sand	3	2	3
Gravel	5	4	5
By weight:			
Water	100	72	75
Cement	118	99	79
Sand	319	203	244
Gravel	552	441	431

The general average coefficient of expansion measured was 0.00000627 for slab 1 and 0.00000632 for slab 2. Slab 3 was kept at a temperature of about 80° F., though at times it fell to 70° F. and even 65° F. during Saturdays and Sundays. Daily observations were made early in the work, but later on observations were made once a week only. It is interesting to note (Fig. 1) the immediate and rapid expansion following pouring, lasting about 1 wk. This caused a change of length of about

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[1] U. S. Dept. Agr., Office Pub. Roads Bul. 46 (1912).

0.00012′ per ft. This action was doubtless due to the physical rearrangement of the particles of concrete in the process of crystallization. So far as its effect upon concrete lining for canals is concerned, if joints were not provided, it would cause severe compression of the slab as a whole for about 1 wk. or 10 das., which might cause a slight buckling and crushing. Where joints are used and filled with asphaltum or similar material the tendency would be to force some of it out of place, and for this reason the filling material should not be placed until about 2 wks. after the lining has been laid. It will be noted, however, that the expansion is only 0.012′ in 100′, which accounts for its effect being of no marked importance in practice.

It will also be noted (Fig. 1) that following the expansion period in slab 3 there is a period of contraction lasting about 75 das., during which there is a total contraction at the rate of about 0.042′ in 100′, thus leaving the slab 0.03′ shorter for a 100-ft. length than when laid. If this factor were considered for a concrete lining, assuming that its contact with the material through which the canal is constructed would not retard the expansion, having a co-efficient of expansion of 0.0000045, it would allow a total rise of temperature of about 67° F. before two adjoining slabs would be in contact after the contraction due to setting had been completed. It is evident, therefore, that if a slab were laid in the winter at a temperature of 40° F., the joints opened by contraction would not be closed until the slab had reached a temperature of 106° F. in the summer. Concrete lining is usually placed in canals in the winter or at least when the weather temperatures are cold enough for the above conditions to obtain. If the water carried in the canal is at a temperature of between 40° F. and 60° F., it is evident that the effect of contraction in concrete lining laid at corresponding temperatures will be most noticeable at a time when water-tightness is most desired. For this reason it is essential that some provision be made to secure water-tight joints. It may also be quite necessary to use some elastic material like tar paper to allow for expansion in excess of that which can be taken up by the space formed due to contraction in setting, for in some sections of the West temperatures are likely to be met which will cause this extra expansion, and unless a compressible material is provided buckling or crushing is very likely to occur.

In summing up the results of the experiments at Logan, Utah, and those at the State Univ. of Ia., it may be stated that for concrete slab construction, such as canal lining, in which only one side is exposed and with the other side in contact with earth, a coefficient of expansion of 0.0000045 should be used, but in the case of concrete construction in which all sides are subject to equal temperatures and are not under the conditions of moisture and earth contact found in canal lining and similar construction, a coefficient of 0.0000063 can be used with safety.

JOINTS IN CONCRETE LINING

Owing to the fact that concrete lining expands in warm weather and contracts in cold weather, joints would seem to be an essential feature of such construction. Where no provision by means of joints is made for expansion and contraction, the concrete lining is certain to be subjected to high internal stresses, which increase in intensity until the lining is ruptured. These ruptures occur at the weakest points, and following the directions of least resistance result in irregular fractures which are difficult to repair. They frequently are so small and so irregular that it is practically impossible to introduce any filler into the seams. Even when this is done the alternate opening and closing of the fracture, due to changes in temperature, lowers and in time destroys the effectiveness of such repairs.

On the other hand, joints in concrete lining constitute a weak feature. In strength, durability and water-tightness the best formed joint is inferior to the continuous lining. For these reasons, to which may be added that of extra cost, the distance between joints should be as great as possible consistent with changes in volume due to temperature and the adoption of suitable forms and proper methods of construction.

When forms are used their length is usually limited to the size and weight which can be readily shifted by hand without the aid of special equipment. Even when the forms are of the simplest kind the methods of construction commonly employed place other limitations on the distance between joints. Again, in lining curves, the frequency of the joints depends upon the degree of curvature, the sharper the curve the shorter the distance between joints. Notwithstanding these limitations, the tendency in the past has been to insert too many joints, particularly on straight portions of canals.

The subject of joints in concrete lining is also closely related to the manner in which the lining is laid, whether continuously or in alternate sections. Joints which are adapted to one of these methods may be a misfit when applied to the other. In using either method it is advisable to break joints between the floor and the sides, as indicated in Fig. 2, *a*.

Kinds of Joints—Various kinds of joints are used to prevent cracks in concrete linings:

(1) One of the most common is the plain abutting joint. This joint is simple, cheap, and easily made. Expansion, likewise, is provided for in the frequency of the joints. It has, however, several weak features which render its use open [illegible] of bond between the sections. Were it not for the connection with the bottom at the toe each side section might be regarded as a separate slab, liable to be thrust upward by pressure from behind or to fall backward when the earthen support is removed. Both of these effects are quite probable. Another defect is the difficulty experienced in filling the seam with any material which will render the joint water-tight, it being too narrow to calk.

(2) The abutting joint is frequently modified by introducing one or more plies of tar paper (Fig. 2, *b*). While the paper [illegible] render the joint more nearly impervious, it adds nothing to the bond between the sections.

(3) An interlocking device (Fig. 2, *c*), consisting of a 4-in. strip of corrugated iron, was inserted in each joint of the lining of the North Side Twin Falls Canals, Idaho. If the metal strip is thickly coated with asphalt before being inserted it may prevent leaks. The device likewise secures a fairly good bond.

(4) A pliable metal sheet protected from rust, of the form shown in Fig. 2, *d*, has also been used for such purposes. When section *A* is being laid, the metal assumes the form of a right angle, the vertical part being placed against the form. Before section *B* is laid the upper portion of the vertical is bent down to a horizontal position, as shown.

(5) In the Ridenbaugh canal of the Nampa and Meridian irrigation district, Idaho, tar paper was inserted between the abutting joints, which are spaced 16′ 3″ apart, and a good bond between the sections was secured by short ½-in. steel rods (Fig. 2, *e*).

(6) To overcome the objection of projecting rods in paying by the method just described, the plan of bonding shown in Fig. 2, *f*, has been devised. A socket is formed in section *A* by means of a short ½-in. pipe, and into this is inserted one end of a steel rod 5/16″ in diam. and double the length of a pipe. This contrivance adapts the joint to the alternate method of laying, as illustrated in Fig. 2, *a*.

(7) The form of joint used by the writer on the Snake Ravine retaining walls of the Turlock irrigation district of Cal. is shown in Fig. 2, *g*. In laying the lining in alternate sections the joint with its concave surface may be coated with hot asphalt or lined with tar paper before the adjacent section is laid.

(8) In lining the Davis and Weber Counties canal in Utah, a thin strip of wood coated with asphalt was placed in each joint and extended through about 2/3 the thickness of the lining. The specifications called for the withdrawal of these strips and the filling in of the

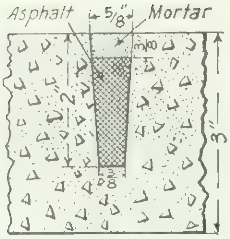

Fig. 3 Joint for Concrete Lining of Canal of Patterson Land & Water Co., Cal.

spaces with hot asphalt, but this was not done. As a result, many of the wooden strips became loose and project more or less above the surface of the lining, thus retarding the flow of water. In other respects the joint has proved satisfactory. (See Fig. 2, *h*).

(9) A somewhat similar joint (Fig. 3) was used by the engineers of the Patterson Land & Water Co. and the East Contra Costa Irrigation Co. On both canals, to which references are made elsewhere, the wooden strips are removed and the spaces filled with hot asphalt to within 3/8" of the surface, the remaining space being filled with cement mortar. When inspected by the writer while the canal was under construction he questioned the advisability of so wide a joint, and was advised that a smaller joint could not well be filled with asphalt.

(10) Where conditions are adapted to its use, the type of joint shown in Fig. 2, *i*, possesses some advantages over those previously discussed. This is merely the carpenter's shiplap or half-timber joint applied to concrete. It provides for all the expansion necessary without weakening the lining by too wide a joint space. It also permits a certain amount of "creeping" in the section without displacement and furnishes an excellent opportunity to secure a water-tight joint by the use of an elastic material like asphalt.

(11) In adapting the shiplap joint to thin concrete linings a greater thickness of lining is used at each joint. The sections shown in *j*, *k*, *l*, and *m*, Fig. 2, represent this modification showing two joints and methods of construction, as designed by A. F. Parker for the lining of the Davis and Uinta Counties canal in Utah.

According to the San Diego, Cal., *Union*, a "cement mistake finder" has been visiting that city "to help the tax payers." When this double-leaded heading is analyzed and the article that follows below it read, it appears that one of the engineers of the Portland Cement Assn. has been visiting San Diego, not to sell cement, but to look the field of concrete construction over, especially so far as road-making is concerned, to point out the best methods of construction and possible improvements and in a general way to bring before the engineering and the contracting public the best that there is in concrete work.

Notes on Procedure in Testing Concrete Piles

By Hunley Abbott[1]

In driving concrete piles it is possible, in most cases, to predetermine the carrying capacity of the pile from its resistance to driving under the last blows of the hammer, using a modified *Engineering News* formula or some other empirical rule. When unusual soil conditions are encountered it is sometimes prudent to test one or more piles with a test load in order to make sure that the unusual soil conditions have not affected the general application of the rule.

CONSTRUCTION OF LOADING PLATFORM

The top of the pile is first thoroughly cleaned and then a concrete cap about 2' thick and 2' 3" x 2' 3" is molded about it, the top of the pile projecting from 4" to 6" into the cap, as shown in Figs. 1 and 2. While the concrete cap is wet a steel bolt is embedded in the center of its top, which is used as a resting point for the level rod when levels are taken to determine any possible settlement of the pile. Two 12-in. x 12-in. timbers are placed on the top of the cap parallel to each other and about 3" apart, and on top of these and at right angles four other 12-in. x 12-in. timbers are placed in such a manner that the weight of the platform will be equally distributed over the four. On these 12 x 12's a platform of 3-in. plank is laid, leaving a hole in the center of the platform to enable the level rod to reach the bolt in the cap. A tin tube is placed vertically over this hole, of such a length as to leave the top of the tube above the top of the expected load. In other words, a platform is built balanced on top of the concrete cap, like an inverted grillage. During the loading of this platform blocking may be placed under the 12-in. x 12-in. timbers to avoid tipping caused by any unequal loading, but when the load is all on, these blocks should be removed, leaving the loaded platform balanced on top of the cap and all of the load being carried by the pile.

Should heavy material, such as pig iron or cement in sacks, be available, the platform as described above can now be loaded. Should, however, material such as sand or broken stone be the only available material with which to load the pile, a box should be built with 4-in. x 4-in posts at each corner and midway between the corners the sides should be further strengthened by 2-in. x 4-in. timbers placed vertically. To these verticals 2-in. planking is nailed to the desired height, thus forming a square box with the platform acting as the bottom and the top open. Into this box the sand is thrown until the desired weight is obtained.

LOADING THE TEST PILE

Before placing any weight on this platform, however, a reading should be taken with the level rod resting on the top of the bolt embedded in the concrete cap. Further readings may be taken by lowering the rod down the tin tube in the center of the platform during the loading to ascertain what settlement, if any, occurs at the various stages of the loading, a final reading being taken when the load is all on. The total load should be allowed to remain on for several hours and readings taken to ascertain whether or not any further settlement occurs. The experience of the writer covering more than 100 tests in all sorts of soils, indicates, however, that, if the pile shows any tendency to settle at all after receiving the final load this tendency is relatively small and the pile will come to a complete stop in a very few hours after receiving the final load. It is believed that 24 hrs. will be ample in all cases to settle this point.

Loading the test pile under the conditions outlined above will approximate as nearly as possible the conditions under which the pile will receive its intended load of the structure. Care should be taken to keep the load well balanced on the pile, as an eccentrically placed load may cause the platform to tip and fall or set up bending stresses in the pile head which would be sufficient to break it.

For molded-in-place piles at least 3 wks. should be allowed for the setting of the concrete before load is placed on the pile, even under the most favorable conditions, and better results may be obtained by waiting 4 wks. for the pile to set.

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[1] Vice-Pres. and Chf. Engr., MacArthur Concrete Pile & Foundation Co., N. Y. C.

TEST ON PILES AT THE LYNN GAS & ELECTRIC CO., LYNN, MASS.

A total load of from 85,000,000 lbs. to 90,000,000 lbs. is carried on the foundations for the 5,000,000-cu. ft. gas-holder of the Lynn Gas & Electric Co., Lynn, Mass., consisting of about 1,500 pedestal concrete piles,[2] which were capped by a circular reinforced concrete cap about 206′ 6″ in diam.

The soil on which the piles were driven consists of a surface material of old fill and gas-house refuse, overlying a layer of marsh mud with a sub-soil of old sand and gravel beach. The piles were driven down to rest on the sand and gravel beach, and have an average length of from 13′ to 14′. Several of these piles were tested with a test load, a view of one of these tests being shown in Fig. 3. It will be noted that instead of assuming the usual bulbous shape on the base or foot, it has almost the shape of a cone. This was due to the soft nature of the soil in which the bulb was formed and the hard nature of the soil on which it rested. The pile carried a load of 75 tons.

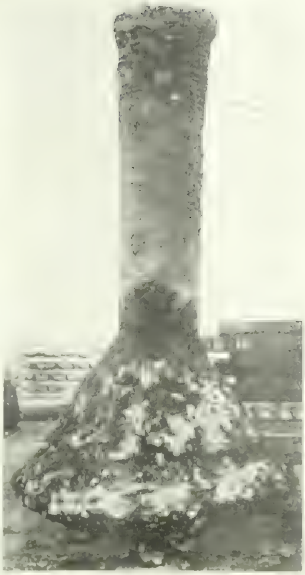

Fig. 3 View Showing One of the Concrete Piles for the Lynn Gas & Electric Co., Lynn, Mass., Removed for the Purpose of Examining the Shape of the Bulb

It will be noted that instead of assuming the usual bulbous shape on the base, it has almost the shape of a cone

Tests of Mortars

H. Burchard, the well known German cement expert, writing in the *Miteilungen Königliche Material Prüfung*, gives considerable information in reference to methods for determining the sand strength of mortars. The paper is abstracted in the *Journal of the Society of Chemical Industry* and is as follows:

The usual way of expressing the composition of mixtures of cement and sand, in the form 1:2, 1:3, 1:4, etc., is somewhat indefinite, because [illegible] 1:4 [illegible] the amount of binding material is comparatively insignificant. Experiments were made with two Portland cements, A. and B., and two iron-Portland cements, C. and D., A. and C. being of slightly higher quality than B. and D., judged by the results of normal tests. Tensile and crushing strengths were determined of mixtures of cement and normal sand in the ratios 1:2 up to 1:7 (by weight) after 7 das., 28 das., and 180 das. under water, and 28 das. and 180 das. exposure to air. The strength of cements decreases with increasing additions of sand, but the decrease varies with the character of the cement, method of exposure and strength and age of the test-pieces; it is greater in the "fat" than in the "lean" mixtures, but is not so marked as would be expected from the decrease of binding material. The decrease in strength with increased sand-content is greater with the newer than with the older test-pieces, and the decrease of tensile strength is less than that of the crushing strength. Hardening in air instead of under water does not affect the strength and there is hardly any difference in the strengths of Portland and slag cement. The mixtures for the above test-pieces were made by weight, and hence the specifically lighter cements would be favored, for a larger volume of the binding material would be introduced than in the case of the heavier cements. The sand addition also affects the progress of the hardening process. When the test-pieces are left under water, the tensile and the crushing strength in all cases increase with age, and increase more with the "lean" than the "fat" mixtures. Cements with a lower normal strength, when mixed with sand, develop in time a relatively greater strength than cements with a higher normal strength. From the tensile strength it appears that the hardening process in test-pieces exposed to the air is not so complete with increasing sand dilution as in the case of test-pieces hardened under water. With air-hardened test-pieces the crushing strength up to 28 das. is greater than with water-hardened test-pieces.

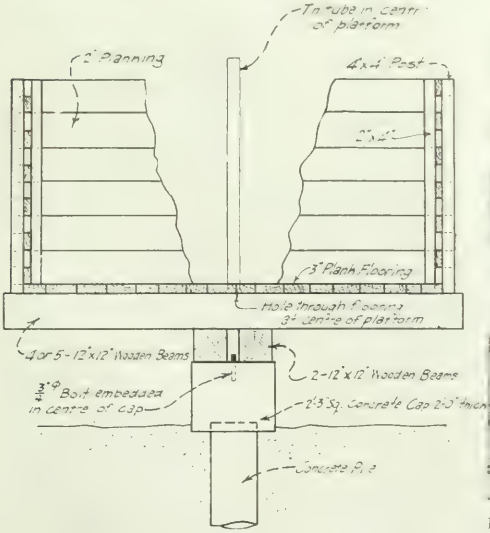
Tn tube in centre of platform
2" Planning
4x4" Post
2"x4"
3" Plank Flooring
Hole through flooring at centre of platform
4 or 5 - 12"x12" Wooden Beams
2-12"x12" Wooden Beams
3/4" Bolt embedded in centre of cap
2'-3" Sq. Concrete Cap 2'-0" thick
Concrete Pile

Fig. 1—Sketch Showing Method of Testing a Concrete Pile

Fig. 2 Test of a Concrete Pile for the Lynn Gas & Electric Co., Lynn, Mass.

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[2] MacArthur Concrete Pile & Foundation Co., N. Y. C.

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Does Mortar Made From Fine Sand Harden Slowly? Why?

THE QUESTION BELOW IS DISCUSSED BY:

NATHAN C. JOHNSON[1]
RALPH E. GOODWIN[2]
RUSSELL S. GREENMAN[3]

Do mortars made from fine sand harden more slowly than when made from coarse sand? Why?

BY MR. JOHNSON

Fine sands always require more water because of the greater surface which has to be covered in such sands as compared with coarse sands, regardless of the interparticle or void space between the grains, as may be judged from the well known mathematical law relating to diameters and surfaces of spheres.

Increased water means dilution of the hydrated products; and before this can effectually harden there must be a drying out or evaporation of the excess water. Hardening is not setting, the two processes being distinct and the time of set not being so materially altered by excess water as is the process of hardening.

BY MR. GOODWIN

Fine sand makes weaker mortar than coarse sand because the density of the fine-sand mixture is less. A given weight of fine sand containing the usual amount of moisture occupies more volume and consequently contains a larger amount of voids than an equal weight of coarse sand. This may be due to separation of the fine particles by the surface tension of the moisture while the larger particles of the coarse sand are fewer in number so that the effect is less.

Tests prove that a given weight of fine sand makes more mortar than the same weight of coarse sand. Hence the compactness of the mixture is less and the strength is less also.

In support of the proposition that fine sand mortar hardens more slowly than coarse sand mortar, we have the authority of text-books[1] verified by tests in our own laboratory. Although fine-sand mortar may improve with age, we do not approve of using it, because it does harden slowly and never attains the strength of coarse-sand mortar. Concrete made from it is weak and appears porous when the fractured surface is examined. On the other hand sand that is too coarse makes a harsh working concrete and it is difficult to get a good job with it. A good rule is to use a graded sand as coarse as can be used with good results in the field.

As to why fine-sand mortar hardens slowly, I am unable to say, unless it is due to the mechanical effect of the small size of the individual voids, of the small size of grains and of the relatively large surface of the grains on the crystallization of the cement.

BY MR. GREENMAN

To say that all fine-sand mortars harden more slowly than do coarse-sand mortars is a reckless statement, for there are other conditions existing in some sands which would make some coarse-sand mortar harden more slowly than would a mortar made from fine sand. Still, as a general proposition the writer believes that the statement is true that fine sands harden more slowly than do coarse sands.

To secure data to back this opinion, five samples each of sands which to the eye are graded as fine or coarse sands were selected from a large number of samples,—the samples being selected at random and being sands having a varying degree of fineness both in the coarse and in the fine grades. The samples were selected on looks only and during the examination it was later found that they came from all parts of New York State and no two samples were from the same pit.

The average strength of the samples of fine sand increased in strength 50% from 7 das. to 28 das., and the average strength of the coarse samples increased 41% during the same period. Each individual strength used in securing the averages was the average of five briquettes.

Another selection of five samples each was made under exactly the same conditions as the first selection and the averages of these showed an increase in strength from the 7-da. period to the 28-da. period of 65% for the fine and 62% of the coarse sands.

The highest increase in strength was the case of a fine sand which showed an increase of 95% and the lowest was that of a coarse sand which showed an increase of 14% only. An interesting point noticed in connection with the two series is that in the first series the average strength of the coarse sand was 80% above the fine sand; in the second series the difference was 24%.

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[1] Consult. Concrete Engr., N. Y. C.

[2] Jr. Engr., Phys. Test. Lab., N. Y. C.

[3] Res. Engr. in charge Tests, N. Y. State Engrg. Dept.

[1] Taylor & Thompson, *Concrete, Plain and Reinforced.*

This simple examination has produced figures which confirm the general statement made, that the rate of hardening must be judged by the increased strength produced; but in either series the differences are not so great that one should consider the rule as being always true. It also indicates that sands so vary that only a carefully made series of tests will give a definite knowledge of the characteristics of a sand and an indication of what to expect of the sand in use.

Now, if coarse sands harden faster and produce a greater early strength, the question asked is "Why?" The greater strength in the coarse sand is undoubtedly due to the fact that a coarse sand produces less surface area for the cement to cover. Having covered the surface area of the sand the cement must also fill the voids between the sand grains. The cement therefore has a greater task to perform with a fine sand than with a coarse sand. Similarly a fine-sand mortar requires more water than does a coarse-sand mortar to produce the same consistency and as it is a fact that the amount of water affects the strength of cement and that the cement with the most water produces the lower early results, we can see that this is a reason why fine-sand mortars harden more slowly than do coarse-sand mortars.

Cost of Cement Sacks to the User[1]

THE QUESTION BELOW IS
DISCUSSED BY:

SANFORD E. THOMPSON[2]
DONALD B. ADAMS[3]
O. L. CRIGLER[4]
ROLF R. NEWMAN[5]
W. W. WASHBURN[6]

"I should like information on the cost of cement sacks to the user of cement. What likelihood is there that general contractors and concrete products manufacturers will decide to use Portland cement in bulk rather than in paper or cloth packages? Figuring the losses of cloth sacks and the flat charge of paper bags, plus the cost of breakage, and adding to these the cost of handling the packages on the job, what would be gained in the use of bulk cement?"

BY MR. THOMPSON

Shipment in bulk cannot be considered at all for ordinary conditions. Cement can be used in bulk only on a large job with a fixed plant located close to a siding and especially designed for the purpose. Cement is difficult to measure by volume because of the great variation between packed and loose measurement, and one of the advantages of bags or barrels is the means of providing a definite quantity for each batch without special weighing or measuring apparatus.

It is impossible to compare the cost of handling in bulk vs. handling in packages without a detailed study of each individual job. The time of a man handling and dumping bags of cement is frequently determined, not by the actual time occupied in the process, but by the time of the man supplying the sand and stone to the mixer. In some cases handling cement in bulk might be cheaper but in many cases more expensive.[7]

BY MR. ADAMS

I have always considered that the use of cement in bulk for factory work would be very much appreciated by manufacturers of concrete products who have a fixed point of delivery and a fixed mixing plan. For a long time we bought cement in cotton bags. It is easy to handle in this shape and there is practically no loss from breakage en route or from handling in the factory. It does, however, require time to open the bags, time to empty the bags thoroughly, time to collect, bundle and ship the bags. Out of 100 bags we found it impossible to get credit for more than approximately 90% owing to loss in our factory and carelessness of the men in using empty cement bags for all sorts of purposes which render them practically useless. We are greatly troubled with men who grab up an empty cement bag and use it to wipe up some wet cement, and in doing this, make a wad of the bag which, when allowed to harden, renders the bag practically useless either to us or to the manufacturer. There is a great tendency to use empty sacks to lay between finished pieces of stone and from these causes we find many damaged sacks, in spite of the greatest attention of foreman and superintendent. We have recently been using paper bags and find them more satisfactory than cotton. There is always considerable breakage on the road in handling, but at the factory this can easily be saved. The car is thoroughly cleansed out and a bag broken in handling in the factory is always cleaned up and used. We figure that the paper bag with its extra flat charge which is involved is a fraction of a cent cheaper than the cotton sack. There is no reason why a car load of bulk cement should be wasted in the slightest degree when once it arrives on the track at our factory. Certainly a car load would not lose a sufficient quantity of cement to compensate for the price which is paid for the paper bags. For our class of work bulk cement would be extremely economical over the present methods of shipping.

BY MR. CRIGLER

Bulk cement is, according to all data which I have collected on the subject, very economical at times.

I think that beyond a doubt, in the construction of bridges, dams, and the heavy concrete, bulk cement is very profitable; and also bulk cement can be used to great advantage where it can be centrally located.

On a large walk job recently I watched the costs of handling very closely and after using 3,500 bbls., found that the costs in the different lines, such as unloading, re-piling and finally the shaking and wiring had cost, not figuring the loss in wet and broken sacks, 11.2 cts. per bbl.

On another job of paving, in which I used 10,000 bbls. I found that the losses were 300 sacks by water, 200 came torn, and another 300 were destroyed by wagons. On this particular job I was careful to hold the percentage down as low as possible.

We seldom think of the loss in cement where the bags come untied and part of the cement is wasted on the ground, so that in figuring the costs there are several minor losses that we have been unable to estimate.

We shall have to take into consideration the fact that there are some losses in the use of bulk cement, but if the contractor will stop and estimate the costs and then keep a close account of them, he will be surprised at the difference in the figures.

BY MR. NEWMAN

I believe that cement in sacks is too convenient as regards carrying portioning by the sack or sacks full for the small contractor for him to give them up readily. On a large concentrated jbo it is different and bulk cement can be used to advantage but in most building construction, and small house construction in particular, it is essential that the cement be delivered in small packages. If reasonable care is taken every sack can be returned without loss to the contractor. Personally, I have never regarded paper sacks as anything more than a makeshift, but I see much in retaining cloth sacks.

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[1] This question was discussed in the Nov., 1914, issue, p. 212, by James Bentley, S. H. Wightman, Benjamin A. Howes, H. C. McClure, L. C. Wason and Carl H. Fuller

[2] Consult. Engr., Newton Highlands, Mass.

[3] New England Cement Stone Co., Boston

[4] Dallas, Tex.

[5] Riverside, Cal.

[6] Resident Engr., Bridge Dept., Houston, Tex.

[7] Detail times and costs of handling cement in packages are given in Taylor & Thompson's *Concrete Costs*, pp. 317, 421 and 435

By Mr. Washburn

I do not favor the use of bulk cement except under especially advantageous circumstances. On large jobs where the cement can be unloaded directly from cars into bins, the saving gained by the use of bulk cement will amount to from 4 cts. to 7 cts. per bbl. according to conditions and methods used by the contractor.

If the specifications do not require weighing of the cement as it goes into the mixer it need not be handled after being unloaded, for it is a comparatively easy matter to arrange a device for measuring the cement automatically by the use of an adjustable cut-off apparatus worked with a lever. Of course, there is some waste in unloading the cement. I should say that shipping cement in the bulk cuts down the loss caused by leaky cars, and cement is sometimes shipped in leaky cars.

If the work is so situated that the cement has to be hauled from the cars to the work, sacks may be used and refilled time after time. However, using sacks in this manner, there is bound to be a loss on them and, in addition, the additional cost of loading the cement in this manner. For obvious reasons, I do not believe that bulk cement will ever be used on anything but very large jobs.

Relations Between the Architect and the Engineer

The Following Questions Are Discussed By:

T. L. Condron[1]
David W. Morrow[2]
Burt D. Fenner[3]
A. Morgan Smith[4]
Robert D. Snodgrass[5]

1. Are the engineers' plans to be supplementary to the architects', and to be so designed that they conform to the general design as given by the architect, in regard particularly as to measurements of floor heights, sizes of window and door openings, cornice details, framing, etc., or do the engineers' reinforcing plans supersede and control the architects' designs, the design to be changed in order to work to the reinforcing plans?

2. If the reinforcing engineer in working out his plans finds that he can make a more convenient, more economical or better design in any way, should he not confer with the architect before changing his design in any material way?

3. Is an architect, in approving designs for reinforcing submitted by a reinforcing engineer, supposed to check over and be responsible for measurements, size of steel, shape, location and placing of steel and for the plans being so that the working out of his design can be made, or is the reinforcing engineer solely responsible for the correct design of his work so that the architect's plans can be carried out?

By Mr. Condron

We do not like the term "reinforced concrete engineer" any more than we would favor the term "wooden" engineer. Where an engineer and architect are employed, their work should be harmonious in every particular and usually the engineer and architect are associated or the engineer acts as consulting engineer to the architect.

It frequently happens that certain "commercial engineers," in order to sell material or for other reasons, endeavor to "improve" upon the architect's plans by materially changing them or by substituting an entirely different form of construction than was originally called for. This is sometimes done in accordance with the architect's wishes, but more frequently it is done regardless of his wishes. It is unfortunately true that many plans for buildings are sent out that have not been well designed structurally and an experienced structural engineer can improve upon the design and cheapen the construction to the advantage of the owner. But in our opinion such substitutions or changes should only be made to the professional adviser of the owner. If the owner has not selected a competent adviser, that is his misfortune.

Where an architect is employed and reserves to himself the right of approving general and detailed structural plans, particularly where he requires the contractor to furnish the general structural plans, subject to his approval, the architect must assume the responsibility to pass upon the design as to strength and adaptability. Our experience is that very few architects are willing to assume any responsibility in approving plans submitted by contractors, but certainly the technical adviser of the owner must take this responsibility. The architect's responsibility should not extend to detailed dimensions except where they affect other features of the work or where they involve the actual strength of the structure. The contractor should be required to make his work fit together and fit with other work on the building.

It not infrequently happens that the specifications provide that the contractor shall submit structural plans showing a design capable of carrying the definite loads with definite unit stresses and all subject to the architect's approval, when the architect is not competent to pass upon the plans submitted and fails to employ anyone who is competent. Numerous instances have come to the attention of such a situation, and to make matters worse the contractor at times has shown no more knowledge of structural designing than has the architect, with a result that the structure has been built in a most unsatisfactory and almost criminal manner. No one would pretend that this represents first-class practice but, unfortunately, it is not rare.

So long as some architects leave structural designing to be done by those whose only object is to reduce the cost below that of any other designer there will be a serious question as to the kind of professional services rendered by "reinforced concrete" or other "material" engineers.

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[1] The Condron Co., Chicago

[2] Consult. Engr., Cleveland

[3] Secy., Am. Inst. of Architects, Washington, D. C.

[4] Architect, Mt. Lebanon, Pa.

[5] Chf. Engr., Trussed Concrete Steel Co., Youngstown, Ohio

By Mr. Morrow

1. The engineer's plans should supplement the architect's and, if possible, the general design of the building should not be changed. If for any reason it is desirable or advantageous to vary from the architect's plans, the matter should be taken up with him.

2. The engineer should confer with the architect when he finds that he can materially better the design without defeating that which the architect has been striving to accomplish.

3. The engineer should be responsible for his design and if looking after the supervision, should see that all steel is properly placed. The architect's and the engineer's plans should agree.

By Mr. Fenner

I shall be glad to give you my personal opinion in answer to the three questions which you ask. You will appreciate that my answers must be considered as personal, for there has been no opportunity to submit the questions to the Board of Directors of the Institute.

1st. If an architect makes the design for the building, it is unquestionably the duty of the engineer to fit his work to that of the architect.

2nd. It very frequently happens that the engineer in designing his structural members will find ways in which slight changes in the architect's design would result in more convenient or more economical construction. In such cases it is undoubtedly his duty to call the matter to the architect's attention, and to work in co-operation with him.

3rd. The architect checks the engineer's drawings in order to see whether or not they correctly interpret and carry out his design. The architect does not assume responsibility for every measurement, size of steel, etc., for this is precisely the service for which the engineer is employed.

By Mr. Smith

1. Assuming that a large building is to be erected in which the major portion is of reinforced concrete, the architect knows no more about concrete design than does the concrete engineer about architectural proportions. The architect gives the engineer a general architectural arrangement, also floor heights, window openings, floor loads, etc., to work on. From this on the architect may be obliged to change his architectural scheme to suit the designs of the engineer.

2. If the architect, through unfamiliarity with concrete architecture, should outline a building far from a practical concrete arrangement, it would seem altogether proper for the engineer when he saw that a proper and economical concrete design was disarranging the architect's plans, to warn the architect what was likely to happen his plans.

3. If the architect is competent to check over concrete sections, sizes and spacing of steel he may place himself responsible for the proper working out of the engineer's designs and relieve the engineer of any further obligations.

There is no doubt but that the engineer should be responsible for the correct design of his work so that the architect's designs can be carried out, provided that the architect's detail plans have been available.

By Mr. Snodgrass

We fail to understand why your correspondent differentiates between the reinforced concrete engineer and any other engineer that the architect may find it necessary to use on his design for a structure. We believe, therefore, that an answer to this question should be general and refer to the whole engineering design, rather than simply to the reinforced concrete that may be used in a structure.

1. As a rule, the architect on the building is employed by an owner to lay out a structure which will not only please him architecturally, but is of the proper dimensions for story heights, window openings, door openings, etc. If the architect is not an engineer himself, he must necessarily employ a structural engineer to look after the structural features of the building for him. It, therefore, remains for both the architect and the structural engineer to work in unison, in order to determine the column spacing, the story heights, and all other features of the structure which the owner may desire. It is the engineer's part to provide as cheap a structure as possible which will meet the architectural requirements.

2. There should be an effort on the part of both the architect and engineer to make the structure as economical as possible, at the same time giving due consideration to the owner's desire for architectural effects and arrangement. The architect and the engineer should co-operate to secure the cheapest structure possible that will meet the required specifications.

3. The architect and the engineer employed on a building should each be responsible for his own part of the structure. It would be entirely foolish to request of an architect that he check and approve the strength of a structure when it is the engineer's business to do this. However, the architect should certainly check and approve the engineer's drawings in so far as they concern the architectural features of the building, such as location of openings, size of members to meet the architectural effects, headroom and all other features of the engineer's design which may be strictly regarded as part of the architectural requirements.

It would appear from your questions that you have in mind more the application of a design prepared by a manufacturer of reinforcing materials than the relation between an architect and a consulting engineer, both working on the same proposition. If the former is the case and if the architect relies upon a manufacturer to supply him with a design, he should undoubtedly check this design to determine whether or not it meets his architectural requirements and at the same time he should appoint an engineer to approve the plans structurally. The average manufacturer of structural materials is honest and attempts to give the architect all that is asked for in his specifications; nevertheless, there may be a few isolated cases where the manufacturer is more anxious regarding his own profits than the proper design of the structure, and in order to secure absolute protection against such a condition and also in order to protect himself, the architect should employ an engineer. It must be remembered that when an owner employs an architect to execute a building for him, he expects to receive engineering as well as architectural service.

Among the new uses for concrete is a guard-rail to be used in connection with railroad track. A company under the name of the Auer Concrete Guard Rail Co. has just been formed at White Plains, N. Y., for the purpose of manufacturing and dealing in reinforced concrete products, contracting for bridges, roads, guard rails and so forth. The principal purpose of the company is the construction of guard-rails and other similar track specialties.

Correspondence: A Department in Which the *Reader* Becomes the *Writer*

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow."

The Use of Crushed Brick in Concrete

A Letter From Carl H. Fuller[1]

While chief engineer of an electric railway in the South, the writer had considerable experience in the use of crushed brick as concrete aggregate.

The high price of $2.50 per ton for crushed granite led to the investigation of other substitutes in ballast. Paving, building operations and other construction work about town afforded a large amount of debris in the way of granite curbing, broken concrete, paving block, building brick and sewer tiling which could be had for the hauling. The sewer tiling came from a factory manufacturing that product and was therefore clean. Having the cars, labor and a rock-crushing outfit, the writer began a campaign to secure all of this material available, intending to crush and use it as ballast under tracks. In the beginning all of this material was piled promiscuously together in the yard and crushed at opportune times.

Having occasion to concrete around some special track work in a hurry, some of this mixed ballast was screened and used for aggregate, producing such good results that we made it a point to separate all of the clean rock from the other materials, intending to reserve the rock for concrete, but soon the demand for concrete materials led to the further separation of clean, vitrified paving block to be crushed for this purpose. Later, experiments were made with all of the other varieties of crushed aggregates and the following conclusions drawn from such work:

Crushed vitrified paving block, when not contaminated with paving pitch or asphaltic fillers, make a good, sound concrete having a strength closely approximating that made from the finest granite, but should not be used for patching or adjacent to rock concrete where it is objectionable as it has a darker and more distinctive color. When crushed to ¾″ and under, it gives most satisfactory results in thin reinforced work and floors.

Crushed sewer tiling bring practically the same material gives nearly as good results, the slight glaze having no apparent bad effects.

Crushed building brick, usually being of a softer nature, do not produce quite so strong a concrete, but are a most acceptable substitute in foundations for paving operations or walls where mass rather than strength is desired. Unless all of the brick are hard burned, considerable care should be exercised in using them for any other purposes. The resulting concrete has a distinctive reddish color.

Re-crushed concrete makes a good aggregate for mass work or paving operations but unless the original concrete was of exceptional good quality its use should be avoided, where strength is desired, as it is usually much inferior to fresh stone.

All of the materials should be thoroughly cleaned before crushing, all dust screened out after crushing and if possible, washed with clean water as the crushing operation produces a large percentage of fine dust that is highly detrimental to making good concrete.

Building brick that have been laid up in sand-lime mortar should have all mortar carefully removed before crushing, though sometimes the crushing and screening will do this work effectively.

Paving block that have been laid with cement grout do not need to be cleaned, as the crushing and screening will effectually remove all the loose cement.

Paving block that have been laid with pitch or asphalt fillers should be carefully and thoroughly cleaned before crushing. This is imperative as the cement will not adhere to the particles of pitch or pitchy surfaces. If such brick must be used they can be cleaned by racking up in kiln formation and building an intense wood fire under them until they are burned clean. Coal should not be used for this purpose as it leaves the faces of the brick with a greasy surface. They may also be cleaned by hand in cold weather but results are generally unsatisfactory.

All such material should be thoroughly wet before using. The best way is to charge the empty mixer with the water, first, then add part of the cement, the crushed brick, sand and balance of the cement in that order. By so doing the porous material will become impregnated with the cement thus adding considerable strength to the final product. This method of charging also has the merit of leaving the mixer clean at all times.

Concrete made with brick aggregate should be rich in cement as the porous nature of the aggregate absorbs more of the finer particles than ordinary stone but when handled as described, test pieces will almost invariably break through the brick, proving the concrete to be equal to or greater in strength than the aggregate used.

Soft-burned or adobe brick should never be used as such material has a very low tensile strength and some of it readily crumbles to dust.

For exposed surfaces, crushed vitrified pavers or hard burned building brick of all kinds, if brushed out when the surface is green, scrubbed with acid or tooled, presents a delightful mottled appearance and the color effect may be varied through quite a range by using a little care in the selection of the materials.

These experiments and observations proved that good hard-burned brick and clay products when clean and handled in the proper manner will produce results quite equal to other aggregates, while a little good judgment in their application will find many uses for such material in the better grades of work.

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[1] Greensburg, Pa

[2] Material of this nature was used successfully and with attractive results in the work of the Sage Foundation Houses Co., under the direction of Grosvenor Atterbury, at Forest Hills Gardens, Long Island. Facing aggregate consisted of crushed red tile. See Concrete, Jan. 1915, p. 3.—Editors

Importance of Cement Volume in Tests of Aggregate

A LETTER FROM H. C. JOHNSON[1]

I beg to draw the attention of those engaged on researches in concrete to a few points that numerous tests, which I have made from time to time, suggest to me.

First and foremost, I wish to make a strong appeal to those engaged on concrete research, not only to give the usual information, such as proportions of mix, sizes of material, age, etc., but to give also the following very necessary item: *The percentage of a cement content in the finished concrete,* or, in the form of a fraction,

$$\frac{\text{Volume of cement used}}{\text{Volume of finished concrete.}}$$

In order to show the need for this I will state that out of 20 mixes of concrete, using different materials, to the common proportions, 1:2:4, and all made for the same purpose and at the same time, there was produced a minimum ratio

$$\frac{\text{Vol. cement}}{\text{(Fin. volume)}}$$

of 1:5.6 and a maximum ratio of 1:4.33, these being based on the dry volume of cement introduced. If based on the wetted volume of cement, the ratios become 1:8.0 and 1:6.2.

The next point is that the one with the least cement was weakest, while the one with most was strongest. The weakest was gravel and the other stone. Now that, to some, condemns gravel; but they are unfair. Give the gravel an equal chance by allowing it as much cementing material for the finished volume of concrete produced as with the stone, and also by reducing the ratio of sand to large material; it will be found, all other things being equal, (materials of approximate equal size, equally clean and same treatment) that practically no difference will exist. Two reasons exist for the suggestion to use less sand:

(a) Gravel contains (usually) a smaller percentage of voids than stone.

(b) Gravel is more easily "lubricated" into position by the sand and cement than is stone, because of the rounded particles.

The third point is that on the usual specification for 1:2:4 concrete, the contractor using gravel can produce a structure of a given size with the use of 100 tons of cement; whereas another would use 128½ tons in a stone concrete.

There are two ways of looking at this:

(a) The Contractors'

(b) The Engineers'

The contractor could save 28½ tons of cement, plus the saving in not having to handle this quantity—a total saving worth effecting. The engineer can be sure that his structure is almost proportionately weaker.

It was on reading a report of tests on (1) gravel, (2) limestone, and (3) slag, as large aggregates, all mixed 1:2:4, where the strengths were low for gravel, medium high for limestone, and high for slag, that prompted me to write you. Should this catch the tester's eye, I beg of him to make up another batch of each, but with *equal percentages of cement* and of *equal working consistency,* and report once more with the old figures alongside.

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[1] Engrg. School, University College, Cork, Ireland

Should Details be Furnished Before a Contract is Signed?

A LETTER FROM C. ALEXANDER WRIGHT

The difficulty of obtaining full detailed information of what is really wanted when bidding upon work is one of the serious problems which confronts the contractor today, for it is largely the "detail" which determines what work is really worth.

In estimating cost of building work, the writer knows of no legitimate reason why all the cards should not be laid upon the table, face up.

Should details be furnished before or after a contract is let? To fair-minded men there can be but one answer to this question. If details are not ready when the job is being figured they should certainly be in the hands of the contractor before he is called upon to sign up. Now as details must be prepared and furnished at some time, is there any logical reason why this should not be done at a time when such information would be of the greatest value to the bidder, i. e., when he is making up his prices? Why this keeping back of vital information at that time? It is not to the bidder's advantage, of course. Who is it that benefits? Is it the owner? Or is it for the greater convience of the architect? But whatever the reason, can it be regarded as fair to the bidder? It is obvious that an individual bidder is helpless. He cannot force the issue himself in any particular instance. But collectively through their organizations, contractors might make reasonable and proper representations of these facts to their local architects, with a view to betterment of the conditions named.

Certain remedies have been suggested from time to time. One is the quantity system, which would go a long way towards determining all details beforehand, but pending the general adoption of this modern method of inviting bids, some other remedy is necessary. One that would seem to afford desired relief would be the passage of a city ordinance providing that applications for building permits, for work above a certain estimated cost, should be accompanied not only by the usual plans and specifications but by details to a scale of say not less than 1½" to 1', or sufficient to indicate the character of the work which is to be performed in detail.

It takes no longer to study the details of a structure before a contract is entered into than afterward. It has to be done sometime. The owner who is now so often unduly impatient to see his building started would soon learn to adapt himself to the new condition, if he realized that his architect was simply conforming to the law. There would be just as many buildings erected, and bidders would understand more clearly what it was they were bidding upon.

Why pay high prices and endure slow delivery for structural steel, when in many cases long-span concrete girders and roof trusses would be as economical and even better construction?

Firebrick crushed and washed, used as an aggregate with cement, form an efficient fireproofing, well adapted for lining of ovens, chimneys, etc. Slag concrete is valuable for the same purpose.

Organizations

American Concrete Institute, Leonard C. Wason, President, 27 School St., Boston.

American Concrete Pipe Association, Secretary, E. S. Hanson, 538 S. Clark St., Chicago.

American Highway Association, Chas. P. Light, Field Secretary; Colorado Bldg., Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C. Convention.

Association of American Portland Cement Manufacturers (Portland Cement Association), J. P. Beck, Gen. Mgr., 111 Washington St., Chicago.

Cement Products Exhibition Co., 208 S. LaSalle St., Chicago, Ill.; Robt. F. Hall, Secy.

Mid West Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb.

Second National Conference on Concrete Road Building, J. P. Beck, Secy., 208 S. LaSalle St., Chicago.

The Omaha Convention and Show

The Mid-West Cement Users' Assn. held a successful convention Mar. 1-3, in Omaha, in connection with the annual show. The total attendance at the Show was 7,133. The space for next year's Show, the dates for which have not been decided, has practically all been reserved. The Association elected only one new officer, the president, G. W. Appo, Kansas City, who succeeds G. F. Lillie, Fremont, Nebr. Other officers were re-elected as follows: C. J. Tracy, vice-pres., Loup City, Nebr.; Frank Whipperman, secy. and treas., Omaha.

The attendance at the convention itself was notably good. The second day more than 300 were present. The opening addresses were by James G. Dahlman, Mayor of Omaha, and E. V. Parrish, mgr. of the Publicity Bureau of the Omaha Commercial Club, followed by remarks by the president, Mr. Lillie.

Among the addresses at the convention were the following: "Efficient Methods and Cost of Producing Cement Products," by E. S. Hanson, Editor, *Cement Era,* Chicago; "My Experience with Concrete Construction," by Simon Redbird, graduate of Haskell Institute and Supervisor of Construction at the U. S. Indian School, Genoa, Nebr.; "Permanent Farm Building Construction," by Prof. M. H. Hoffman, Agricultural Dept., Iowa State College, Ames, Ia.; "Insurance and Other Economies of Fireproof Homes," by F. L. Williamson, vice-pres., Dewey Portland Cement Co., Kansas City, Mo.; "Concrete Culverts and Bridges for Public Highways," by A. P. Young, mgr., Wilson Reinforced Concrete Co., Nebraska City, Nebr.; "Paving the Lincoln Highway," by J. B. Marcellus, engr., Assn. Am. Portland Cement Mfrs., Kansas City, Mo.; "The Development of Concrete Construction," by W. A. Collings, Concrete Engr., Kansas City, Mo.; "Relation of Cement Manufacturer and User," by G. M. Wood, Cement Products Bureau, Assn. Am. Portland Cement Mfrs.

Engineering Co-operation Convention

An invitation has been issued by a committee consisting of: F. H. Newell, Chmn., University of Illinois, Urbana, Ill.; C. E. Drayer, Secy., Cleveland Engrg. Soc., Cleveland; Willard Beahan, Past Pres., Cleveland Engrg. Soc., Cleveland; H. H. Esselstyn, Past Pres., Detroit Engrg. Soc., Detroit; Farley Gannett, Past Pres., Engrs. Soc. of Pa., Harrisburg, Pa.; Charles R. Gow, Mem. A. S. C. E., West Roxbury, Mass.; George H. Herrold, Pres., Civ. Engrs. Soc. of St. Paul, St. Paul, Minn.; A. J. Himes, Past Pres., Cleveland Engrg. Soc., Cleveland; John C. Hoyt, Pres., Washington Engrg. Soc., Washington, D. C.; A. Stucki, Past Pres., Engrs. Soc. of Western Pa., Pittsburgh; D. Robert Yarnall, Vice-Pres., Engrs. Club of Phila., Philadelphia; John Younger, Pres., Engrs. Soc. of Buffalo, Buffalo, N. Y., to all engineering organizations to send delegates to a conference on engineering co-operation to be held Thurs. and Fri., Apr. 13 and 14, in the rooms of the Western Soc. of Engrs., 1735 Monadnock Blk., Chicago, Ill. The following items, among others, may be considered:

1. Co-operation among engineering organizations. Is it desirable? In what way is it practicable?
2. Benefits of co-operation in securing greater efficiency in the larger matters of concern to the individual engineer, to the profession and to the public.
3. Methods of co-operation now in practice in various localities; results attained in Philadelphia, St. Louis, St. Paul and other places.
4. Various kinds of engineering societies and committees and the relative efficiency of their operations.
5. Relation of the specialized or exclusive national engineering societies to their local sections or branches and to the more inclusive local engineering society or club.
6. Result of co-operation in securing wider diffusion of knowledge on engineering subjects, as illustrated at Cleveland and elsewhere.
7. The engineering profession as a whole in its present condition as regards public esteem.
8. Reasons for decline in attendance at engineering colleges. Is it indicative of healthful conditions or of proper methods of education?
9. Employment; methods and results as practiced by various engineering societies; an exchange of ideas.
10. Legislative activity, proper limits to be set, dangers to be avoided and needs of more systematic and better directed efforts.

The American Society for Testing Materials

Of the work of the Am. Soc. for Test. Mat., U. S. *Commerce Reports* says:

> The increasing activities of the Am. Soc. for Test. Mat. are fully presented in five publications it has recently issued. The most important of these volumes is the 756-pp. year-book, containing the standards and tentative standards of the Society. Another publication of 250 pp. contains a summarized list of standards, charter and by-laws of the organization, information concerning the Internatl. Assn. for Test. Mat., with which it is affiliated, roll of membership, board of officers, committees, technical problems and numerous other facts of interest to those who have occasion to deal with specifications for materials and allied subjects.
>
> A smaller book, containing information about the Society, states that it was formed in 1898 as a branch of the international organization, was incorporated in 1902 as the American Society, and that it still maintains a close relation to the parent organization. Membership may be held by individuals, firms, corporations, technical or scientific societies, companies, teaching faculties and libraries. The work is done largely through its technical committees, which present reports and recommendations at the annual meeting. There are now 38 technical committees, with a total membership of 932.
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> Edgar Marburg, the secy.-treas., who is prof. of civ. engrg. at the University of Pennsylvania, Philadelphia, announces that four of the bureaus of the U. S. Navy hold perpetual membership in this society, and that at the request of the Baldwin Locomotive Works that company has been granted the Society's permission to publish many of its standards relating to specifications for iron and

Steel products in English, French, Spanish, Portuguese and Russian, with a view to their serving as a basis in the purchase of locomotives throughout the world.

The U. S. Bur. of Standards is represented on many of the technical committees of the Society, and is an active participant in its work. Mr. Marburg calls attention to the fact that similar work in the field of standardization of specifications is being done in England by the British Engineering Standards Committee, under the auspices of the leading technical societies, manufacturers and consumers, and with liberal financial support on the part of the government.

The annual report of the Society's executive committee says of its usefulness:

> The increasing use of the standard specifications of the Society in federal, state and municipal circles, apart from their extensive adoption in ordinary commercial channels, is significant of the confidence placed in the work of the Society, and emphasizes the reciprocal obligation upon the Society to justify that confidence in connection with everything to which its name is attached. It may not be known to the membership at large, for example, that the purchases for the Panama Canal have been made largely under its standards, 27 of the standard specifications of the Society being now used by the purchasing department of the canal; also that the U. S. postal cars are purchased subject to the A. S. T. M. standard specifications. Again, nine of the standard specifications have been adopted—in some cases with slight modifications—in connection with the boiler code recently prepared by a committee of the Am. Soc. of Mech. Engrs., which is expected to be adopted in many states by legal enactment.

New Books

Materials of Construction—By G. B. Upton,[1] cloth, 6″ x 9″, 320 pp., illust., John Wiley & Sons, Inc., N. Y. C.

This book is an outgrowth of the laboratory course in Materials of Construction given to juniors in Sibley College.

It is divided into two parts. The first part deals with the determination of properties of materials by means of engineering testing. The internal phenomena of the structure of materials under load are explained. The ordinary formulas for calculation of stresses and deformations are examined, with the assumptions on which they are based, their ranges of validity, and the direction and magnitude of their errors after they cease to be valid. There is an attempt to teach the student how to interpret and criticize test results, and to formulate binding specifications.

The second part of the book deals with the nature of the internal structure of materials and the control of their properties, through the control of the structure. The principles of physical chemistry concerned in heat treatment are outlined, with many diagrams to make relations clear.

The general analyses for finding the true stresses after the elastic limit in torsion or transverse loading, and the description of heat treatment from the standpoint of physical chemistry as a controlled chemical reaction are believed to be new in their presentation. The new analysis of torsion and transverse loading is already giving results which may clear up the controversy over "Guest's" law or other laws of failure in combined loadings, and may make the tests of ductile metals in direct shear unnecessary. The final chapter is devoted to the testing of cement.

Portland Cement Concrete Pavements for Country Roads. By Charles H. Moorefield and James T. Voshell, senior highway engineers, Office of Public Roads, U. S. Dept. of Agriculture, Bulletin No. 249, 34 pp., 6″ x ″, paper.

The bulletin records the rapid progress of concrete road building 364,000 sq. yds. in the U. S. in 1914 to 19,200,000 sq yds. in 1914. It calls attention to the principal advantages and disadvantages of concrete roads and discusses methods of construction. In part it covers the following subject matter:

The principal advantage of concrete pavements which have led to this increase in popularity are said to be: (1) Durability under ordinary traffic conditions; (2) A smooth, even surface offering little resistance; (3) Absence of dust and ease with which it may be cleaned; (4) Comparatively small cost of maintenance until renewals are necessary; (5) Availability as a base for another type of surface of desirable; (6) Attractive appearance. In commenting upon these advantages, the bulletin states that the durability of concrete roads has not yet been proved by actual practice, because there are no very old pavements as yet in existence, but from the condition of those which have undergone several years' service, it seems probable that they will be found to wear well.

The disadvantages of concrete as a road surface are: (1) Its noise under horse traffic; (2) The wearing of the necessary joints in the pavement; and the tendency to crack, with its consequent rapid deterioration; (3) The difficulty of repairs when these become necessary.

In the past efforts have frequently been made to overcome these objections to a certain degree by covering the concrete pavement with a bituminous wearing surface. At the present time, the specialists in the Dept. of Agriculture hold that this can not be economically justified although it is possible that future investigation may change the situation in this respect. In the present state of road science, however, it seems that where traffic conditions are such that a bituminous surface on a concrete road is practicable a bituminous-surface macadam road would be equally practicable and certainly cheaper. Where traffic is too heavy for a macadam road, the bituminous surface is likely to give way and the uneven manner in which it fails tends to produce excessive wear on portions of the concrete.

For a successful concrete road, hardness, toughness and uniformity are the most essential qualities. These can be secured to a great extent by care in the selection of the constituent materials and the proportions in which they are mixed. Sample specifications are included in the bulletin. These specifications are believed to typify the best engineering practice as it has been developed up to this time. They cover such points as materials, grading, subgrade, and construction.

The cement, it is said, should always conform to some standard specifications for Portland cement, such as those issued by the U. S. Bureau of Standards or the Am. Soc. for Test. Mat. The sand should not contain more than 3 per cent of foreign material, and sand with more coarse than fine grains is to be preferred. The coarse aggregate may consist of either crushed stone or gravel. In either case it is very desirable that the coarse aggregate be well graded in size between proper limits.

The proportion of cement to the sand and coarse aggregate combined should not be less than about 1:5, and the proportion of sand to coarse aggregate not less than 1½:3, nor greater than 2:3. A useful formula when gravel is used as coarse aggregate is 1 part of cement to 1½ parts of sand to 3 parts of gravel. When crushed stone is used, 1¾ parts of sand may be substituted in place of 1½ parts.

In addition to discussing the engineering details of construction, the bulletin calls attention to the fact that ordinarily from ⅓ to ½ of the total cost of constructing a concrete pavement is for labor after the materials are delivered. This emphasizes the importance of efficient organization and proper equipment. Failure to take these factors into consideration frequqently results, it is said, in adding from 10% to 20% to the cost of a concrete pavement.

The most economical method is to have the work of mixing and placing the concrete as nearly continuous as practicable. The work should be planned with a primary view of keeping the mixer going full time. The drainage structures, the grading, and the subgrade should, therefore, be completed well in advance of the mixer and provision made for obtaining all of the necessary materials without delay. A common error is the failure to make adequate provision for delivering water on the work, and the amount which a given stream is capable of supplying is frequently overestimated.

Some Engineering Problems of the Panama Canal in Their Relation to Geology and Topography—Dept. of the Interior, Bureau of Mines, Washington, D. C. Written by Donald F. MacDonald and published with the approval of the Governor of the Panama Canal. Paper, 6″ x 9″, 88 pp., illust.

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[1] Asst. Prof. Exp. Engrg., Sibley College, Cornell University

A Combination Concrete and Wood Pile

By L. L. De Bra

A concrete pile has been designed by K. D. MacLean[1], and is of interest in connection with bridge and wharf construction.

Wooden piers are subject to natural decay and to destruction by fire above the water line, and, in salt water, are destroyed by the teredo and other marine insects. In the ground beneath the mud, wood will last indefinitely. Only recently, wooden piles were removed from the River Rhine which were driven in the time of Julius Caesar and were found to be in good condition.

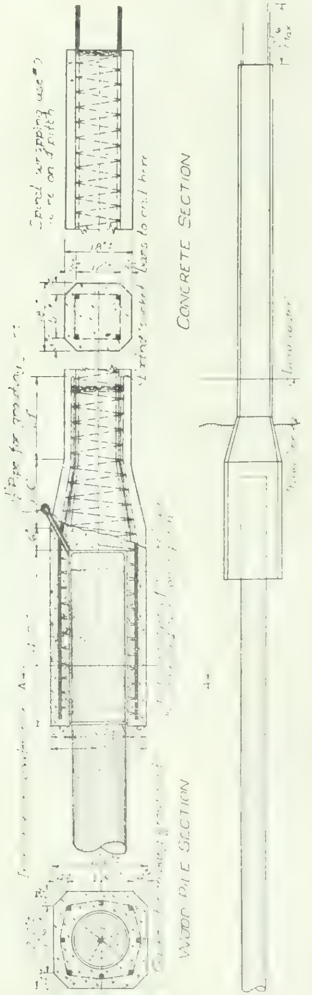

Fig. 1—Concrete and Wood Pile

Fig. 3—Swinging Pile Into Place

For permanent construction in water at a reasonable cost, the concrete pile is the ideal type. It is immune from decay, fire or marine insect attack, and will carry a wood, steel or reinforced concrete superstructure. The ordinary pre-cast pile has, however, one very serious limitation and that is length. On account of its weight and small cross-section, it is difficult, and after certain limits, impossible, to move it and raise it from a horizontal to a vertical position. Hence, it has been used in shallow mud and water only, in connection with bulkhead construction, etc.[2]

The object of the socket concrete pile is to combine the good features of the old type of pre-cast concrete pile, without its defects, with the decreased weight and submerged permanency of the wood pile.

The new pile is constructed of reinforced concrete, molded on the ground in either steel or wood forms prior to driving. One end is furnished with a socket for superimposing upon a wooden pile, the idea being to use the wooden pile in the ground below the mud line and place upon it the concrete socket pile.

Fig. 2—Socket Piles in Yard

Soundings are first made in the usual manner and the length of the wooden pile computed so that its top, when driven, will be a foot or two below the mud line. The pile is then driven to within a short distance of the water line. A collar of burlap or other material is placed around the pile at a point near where the end of the socket will come and the concrete socket pile is then placed over the wooden one. The socket pile is held up about 6″ while all the space in the socket not occupied by the end of the wood pile is filled with grout through a small pipe fitted in the socket for that purpose and the pipe capped. The socket pile is then dropped into place and the heavy pressure forces the grout into all voids. The combined pile is then driven home.

Lengthy investigations made while the inventor was Supt. of Const. of the State Board of Harbor Commissioners at San Francisco demonstrated that the socket is the strongest part of the pile. In one test, the wooden pile was driven until the top was about 7′ above the floor of the dock and left in place from 4:30 p. m. until 8:30 a. m. the next day before driving was continued. The socket pile rested upon the wooden pile over night. Before the driving was resumed, the socket pile was raised about 6″ and the space filled with grout. The pile was 40′ in length, the shaft being 34′ long and the socket 6′ deep. The diameter of the shaft was 16″ and the socket walls were 6″ thick. The reinforcing was eight ⅝-in. corrugated bars[3] wrapped with No. 3 annealed wire, socket wrapped on 3-in. pitch and shaft on 6-in. pitch. It weighed about 5 tons. The pile was driven with Arnott No. 1 hammer, delivering 1,100,000 ft.-lbs. per min. at 110 blows. Hammer worked at about 117 blows.

The first 30 blows caused a penetration of 1′ next 23 blows caused penetration of 18′, next 27 blows 12′, next 110 8′, next 953 blows a penetration of 4′, to refusal. Total blows 1,143. Total penetration of pile (wooden tip) 61′.

About a month later, to test the efficiency of joining the concrete and the wooden portion of the pile, an attempt was made to pull the pile out. State pile-driver No. 1 was used, being equipped with an 8¼-in. x 10-in. double-cylinder triple-drum engine. The pile was slung with a 1½ in. staggered chain with a 1 in. hook and the line from this passed through a pair of 3-sheave blocks, thence to the hook of a single block in the bight of the engine runner, one end of which runner was fastened to the head-block of the driver. The mud was then loosened around the socket of the pile by means of a 2-in. jet and over an hour spent with the purchase above described, trying to pull the concrete pile off the wooden one.

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[1] San Francisco, Cal.

[2] See Concrete, July, 1915, for account of exceptional work at Halifax, N. S.

[3] Corrugated Bar Co., Buffalo, N. Y.

When this attempt was found to be unsuccessful, a floating driver was brought alongside, and with the two machines the pile was pulled forward and backward through an arc of about 110° to see whether or not it would be fractured in the socket. The pile finally broke about 8′ above the socket. A second attempt to pull out the remaining portion was no more successful than the first. The pile still remains where it was driven.

This test was most severe and proved without a doubt that the socket can be depended upon for at least as great an efficiency as the ordinary type of concrete pile.

The socket pile is being used with success in repair work on existing structures.

The following tabulation, showing a summary of all the bid figures received by San Joaquin Co., Cal., June 8, 1915, illustrates the economy resulting by reason of employing a socket pile substructure in place of the concrete cylinder pier on piles:

Bidder	Cylinder Pier Foundation	Socket Pile Foundation	Saving on Socket Pile Foundation
Tibbetts-Pacific Co.	$142,985	$134,740	$ 7,245
Mesmer & Rice	152,790	137,355	15,435
Penn Bridge Co.	154,980	142,400	12,580
Ross Construction Co.	155,164	139,677	15,487
Security Construction Co.	155,950	138,450	17,500
Thompson Bridge Co.	158,766	143,224	15,542
Midland Bridge Co.	158,868	154,258	4,610
California Construction Co.	159,300	135,300	24,000

A Drier "Top" and Long-Handled Tools Speed Up Sidewalk Finishing

Two things in the development of concrete sidewalks make for greater speed, therefore, greater economy in the work, in the experience of N. A. Wood, of the N. A. Wood Const. Co., Detroit. One of these is the use of a top coat much drier than was used formerly for sidewalk work and the other factor is long-handled finishing tools.[1] It appears, however, that success in using long-handled tools and the drier top coat depends a great deal upon the way the sidewalk work is planned. The old schedule for mixing foundation course and top course and for finishing would not work out satisfactorily at all with long-handled, double-action finishing tools. When this was discovered Mr. Wood says that he set up just twice as many side forms as he had done formerly and provided material accordingly. One finisher was dispensed with and given a place at the mixer. The mixer first ran 175 lin. ft. of sidewalk base course, the walk being 6′ wide. Then the mixer was changed to "top" mix. The usual stretch run, using the wetter top mixture and the ordinary finishing tools, was 100′ of base. The top mix used for the speedier work was like thin mortar. This was spread between the forms by two men, one working at each end of a piece of 2 x 4 timber which was used as a straightedge. Each man carried a plastering trowel in one hand and with this trowel the surplus material was kept constantly in front of the straightedge, spreading the mix. The straightedge was given a few sweeps forward and backward over the forms until a perfect fill was assured, then with a final saw-like motion of the straightedge the surplus was swept forward. After the top coat had been placed on 40′ to 50′ of walk, the finisher began his work on that first put down and used a 24-in. float, working the surface lightly crosswise, just enough to smooth down any rough places and remove any air bubbles or close voids that might remain after the straightedge. This left the surface in good condition for troweling. Immediately after using this float the edger was used, also a long-handled tool. It was run down one side and back the other. Then the work was troweled lengthwise. While Mr. Wood admits that there is a vast difference of opinion as to the amount of troweling which is to be done in finishing a concrete walk, he inclines to the more modern view that less finishing with the trowel is not only more economical of labor but actually gives better results. After the first crosswise troweling the finisher set the trowel at a proper angle by means of the wing nut and troweled lightly lengthwise of the walk. After this was done the joints were cut, no dividing plates having been used, the cutting being done in the base course with a steel blade 4″ wide by 16″ to 20″ long. This open joint was filled with clean sand, care being taken to fill the joint entirely full. The top dressing flows over this sand joint and immediately after the first troweling the top surface joint is ready to be cut at the point indicated by the sand filling. A straightedge is placed across the form as a marker and a clean joint is cut. After removing the straightedge the joint is run with the edger, one or two strokes only being required. Such damage as has been done in cutting the joint or in edging is corrected by a few troweling operations. The surface being in good shape, the rolling is done, using the 12-in. line type of roller, and granite dust is applied. On this work, which Mr. Wood particularly mentions, where 175 lin. ft. of bottom course was run before any top mixture was put on, it was found that the time required for the work from the starting of the mixer on "top" until the last of the finishing had been done was just 45 mins.

The English Concrete Institute is following the example of some of its sister societies in this country and is beginning to take more and more to itself the whole business relating to the principles of and construction practice in reinforced concrete. To this end the president at a recent meeting suggested that the Science Committee should have powers to appoint sub-committees on Cement Tests, Research and Failures. All these subjects were deemed to be of the greatest importance and the last named, Failures, the president said, was so important that the Institute should form a special committee whose duty it would be to investigate thoroughly the circumstances which were responsible for any failure and a report should be prepared for circulation among the members of the Institute who would then be able to speak with certain knowledge on each case and at the same time benefit by the experience gained in such investigations.

Wall forms should be provided with occasional hand-holes at different levels to allow inspection before removing forms.

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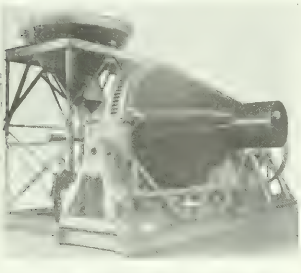
[1] Abram Cement Tool Co., Detroit

New Equipment, Methods and Materials:
New Tools with Which the Industry Works □ □

A Hurry-Up Job Made Necessary Record Size Mixers

A contract for the construction of a large concrete dam at Salisbury, N. C., taken recently by the Hardaway Contr. Co., Washington, D. C., requires the contractor to pour 60,000 cu. yds. of concrete per mo. until the job is finished, the total quantity being about 1,000,000 cu. yds. Looking over the ground, the contractor found that four 2-yd. mixers would take up too much lateral space, and it seemed necessary to have constructed special mixers, of 4-cu. yd. capacity, each mixer to have a capacity of 108 cu. ft. of mixed concrete per batch, or a capacity of about 150 cu. ft. loose, unmixed material,—larger than any concrete mixers previously built. The contractor arranged with the T. L. Smith Co.[1] to build these special mixers, and the two machines required have just been completed—twice the size of the big mixers used in the construction of the Panama canal. Each machine is mounted on steel skids with batch hopper supported by a steel frame. The mixer itself is equipped with power tilts, further equipped with Allis-Chalmers[2] clutch pulley. The weight of each machine is 23 tons and the mixer drum is made of $\frac{3}{8}$-in. steel. The inside diameter of the drum is 9′ 6″.



One of Two Mixers Which Are the Largest Mixers Ever Built To Be Used in the Construction of a Dam at Salisbury, N. C.

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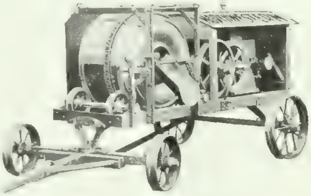
[1] Milwaukee

[2] Allis-Chalmers Co., Milwaukee

The commercial development of machines, tools and materials, and the new methods which their use involves have a most important part in the progress of the concrete field. Announcements of such developments, particularly in reference to their demonstrated importance in actual practice, are welcome. The Editors will select for publication that material which conveys the information of most practical value to the Reader, without regard to other considerations.



Northwestern Concrete Mixer

The Northwestern 5-Foot Mixer

A low cost mixer made in 5-cu. ft. and 10-cu. ft. sizes has recently been developed.[1] While this mixer has brought out no radically new features a number of refinements have been added to well proven principles of mixer design. Some of the points to be noted are the shape of the drum, which eliminates pockets; the large chilled drum rollers and the standard wagon gauge truck with large wheels.

The mixer is chain driven and fitted with a 3-h. p. engine. A side loader is provided when desired, operated by a simple and powerful hoist.

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[1] Northwestern Steel and Iron Works, Eau Claire, Wis.

A Lath Used in Sheet Form

The accompanying illustration shows a new kind of lath, called Buttonlath, put on the market at Los Angeles, Cal.[1] It is manufactured in solid sheets of uniform size and thickness—24″ x 32″ and $\frac{3}{8}$″ thick. The board is of a fibrous composition, covered on the exposed side with numerous indentations, in the center of each of which is set a hard composition button. These buttons are placed $1\frac{1}{2}$″ apart o. c., numbering 530 to the sq. yd. Each is said to be capable of sustaining a weight of 50 lbs.

When employed for exterior work, it is usually covered with a wire netting, of 15-ga. and 2-in. mesh, loosely stretched over the surface. This netting acts as a reinforcement for the stucco, and also increases the bonding quality of the lath.

The cost of this material lies between the cost of wood lath and metal lath and a considerable mortar and labor saving is effected. The material has been used quite extensively in California.

Buttonlath, a New Stucco Base

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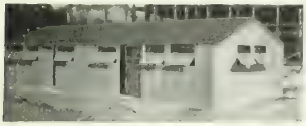
[1] Buttonlath Mfg. Co., Los Angeles, Cal.

Substantial Portable Pressed Steel Buildings

A decided advance in the construction of portable buildings has been made by the introduction of a heavy pressed steel paneled unit,[1] adapted for contractors' buildings and other structures of a temporary nature.

Every detail has been carefully worked out and the buildings are exceptionally rigid and neat in appearance. They can be assembled and dismantled in a very short time, without the use of tools other than a hammer. The illustration shows a building in use as a contractors' office and storehouse.



A Portable Steel Building

A Home-Made Portable Gravel Washer

In view of the great interest in securing better and cleaner aggregate a portable power washer used and described by John Franco[2] is valuable. He writes:

The device is merely a screw conveyor set into a pipe. The contractor may use his own judgment as to the size of the pipe and conveyor to be used, being careful to make the conveyor somewhat smaller in diameter than the diameter of the inside of the pipe to permit the free passage of the water, as shown in Fig. 2. The whole device should be set on a frame at an angle sufficient to permit the water to run freely to the lower end to the water outlet. The power can be supplied from the engine either by means of gears, as shown in the sketch, or by a belt or other convenient method. The water is admitted at the upper end, and the gravel shoveled into a hopper at the lower end, as shown at Fig. 1. By revolving the screw conveyor the gravel will be carried to the upper end of the pipe and ejected, after having been thoroughly washed. It might be necessary in some cases to fix a trap of some sort at the lower end of the pipe for the more convenient removal of sediment which may collect there, having been carried down by the water after successive washings.

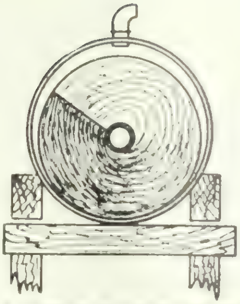


Fig. 2—Section of Gravel Washer at B-B, Fig. 1

This device can also be used successfully for washing sand, with a few minor alterations to suit the changed conditions.

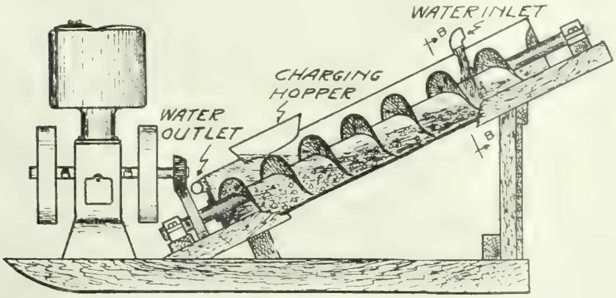
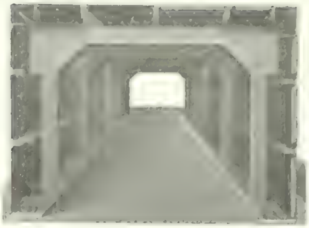


Fig. 1—Section of Gravel Washer
Note shape of skids for hauling

New Form Builds Large Number of Culvert Sizes

The illustration shows an adjustable steel culvert form[1] recently placed on the market. It is composed of pressed steel plates 12″ high with 12-in. x 12-in. bracketed corners with brace angles supporting the roof. The set is adjustable from 2′ x 3′ to 5′ x 6′, by units of 12″ in each direction. Sets are furnished in lengths of 20′, 25′, 30′, 35′ and 40′. These lengths are made up by 5-ft. and 10-ft. sections, secured by rigid slip-joint connections. This form is light in weight and very easily assembled and withdrawn, while the steel surface gives an excellent finish to the work.



Blaw Adjustable Steel Culvert Form

Slag Concrete Shows High Strength

Tests made Dec., 1915, and Jan., 1916, at Columbia University, N. Y. C., on slag concrete and trap rock concrete are described in a report made to the National Slag Co.[1]

The trap rock was graded to ¾″, ½″, ¼″ and dust, and was artificially combined so that the grading was identical with that of the slag, which was used as received.

The sand used was "Cow Bay," a typical Long Island sand, and the cement was a mixture of three standard brands of Portland cement. The mixture of the concrete was in all cases 1:2:4 by volume, and machine mixed. In making up the complement of stone for each batch, proportional amounts of each aggregate were carefully measured by weight. It was thought that this procedure would insure greater uniformity in results.

Table of Ultimate Strength in Lbs. Per Sq. In. Compression Tests of 8-in. x 16-in. Cylinders

	28 das.	3 mos.	6 mos.	12 mos.
Slag concrete ..	2,465	3,496	3,567	4,187
Trap rock concrete.	1,975	2,961	3,053	3,537
Higher compressive strength of slag concrete	490	535	514	650
% higher compressive strength of slag concrete	24.8	18.0	16.9	18.4

Averages given in the table are the results of testing four specimens of both types of concrete at each period.

Report of Determination of Modulus of Elasticity of Slag and Trap Rock Concrete 3 Mos. Old

The specimens tested were three slag and three trap rock concrete 8-in. x 16-in. cylinders. An average value in each case was taken up to a unit load of 650 lbs. per sq. in. with the following results:

Slag (modulus of elasticity in lbs. per sq. in.)........................4,126,000
Trap rock concrete (modulus of elasticity in lbs. per sq. in.)..........4,036,000
The average weight of slag concrete was 140 lbs. per cu. ft.
The average weight of trap rock concrete was 151 lbs. per cu. ft.
Slag weighed 80 lbs. per cu. ft.
Trap weighed 100 lbs. per cu. ft.

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[1] Trussed Concrete Steel Co., Youngstown, Ohio

[2] Contr., San Francisco

[1] Blaw Steel Const. Co., Pittsburgh

[1] Newark, N. J.

Trade Publications

"Superior Lock Concrete Stave Silo"—Swan Concrete Stave Silo Co., Cassopolis, Mich., paper, 5″ x 8″, 12 pp., illust. This is a catalog describing the equipment for making silo staves, which is illustrated in considerable detail.

Kahn Portable Steel Buildings — Trussed Concrete Steel Co., Youngstown, Ohio, paper, 8½″ x 11″, 32 pp., illust. A light, portable steel building of unit construction and neat appearance that can be readily assembled and dismantled and should find many applications. Some of them are described in this publication, which shows a new line of development in pressed steel.

Catalog No. 8—Buffalo Wire Works Co., Inc., Buffalo, N. Y., paper, 8″ x 11″, 176 pp., illust. This large catalog describes wire specialties, including screens of every size, fencing, architectural wire and wrought iron work. It is a reference work on wire products.

How to Mix Concrete and Mortar in Zero Weather—C. A. Londelius & Sons Co., Chicago, folder, 3½″ x 6½″, 6 pp., illust. A low-priced heater of the salamander type so arranged as to deliver a large, continuous stream of hot water, is a piece of equipment that will interest many builders. It is well described in this folder.

The Adjustable Feature — Reichert Mfg. Co., Milwaukee, folder, 3½″ x 6″, 16 pp., illust. This folder features a large and varied assortment of silos and other round structures built with the same outfit of Reichert molds.

The Milburn Light—The Alex. Milburn Co., Baltimore, Md., paper, 6″ x 9″, 52 pp., illust. This catalog shows a wide range of portable lights for emergencies and for night construction. Part of the catalog is also devoted to oxy-acetylene plants for welding and cutting steel.

The Medusa Whitehouse — Sandusky Portland Cement Co., Cleveland, 16 pp. and cover, 3½″ x 4¾″. This little booklet sets forth the architectural appeal in the use of Medusa White cement in connection with concrete house building and contains attractive illustrations and interesting text.

Improved Monarch Concrete Block Machines—Republic Iron Works, Tecumseh, Mich., 8 pp., 8½″ x 11″, paper, illust. Description of improved block machine, illustrating face plates, parts and machine construction.

The Republic Adjustable Cap and Sill Mold—Republic Iron Works, Tecumseh, Mich., paper, 8½″ x 11″, 4 pp., illust. The folder shows the parts and the flexibility of adjustment of the mold for making concrete dimension stone.

A Bull's-Eye Every Time with the Profit Boosting Triplets—The T. L. Smith Co., Milwaukee, folder, 4″ x 4″, 24 pp., 2 colors, illust. This folder is devoted to the various combinations of the Smith Mixerette, a 3-cu. ft. batch mixer. A hoist is furnished in connection with the mixer if desired, making it especially desirable for silo construction.

The Concrete Dope Book—The Cement Tile Machy. Co., Waterloo, Ia., paper, 6″ x 9″, illust. Occasionally a catalog is published that is much more than a catalog. While the purpose of this booklet is to describe the Winner line of concrete mixers, fully half of the space is devoted to concise information of value to the concrete worker. Tables showing the amount of materials required for various kinds of work and in some cases cost data which have been secured from actual operations are given. Numerous little hints and suggestions, together with the information tables, make this a publication well worth securing and preserving.

Medusa Waterproofing — Sandusky Portland Cement Co., Cleveland, paper, 7″ x 9″, 32 pp., illust. This attractive pamphlet describes the use of Medusa waterproofing material and illustrates a large variety of construction where these products have been used.

More Profits in Concrete Culvert Construction—Blaw Steel Form Co., Pittsburgh, folder, 3½″ x 7″, 12 pp., 2 colors, illust. This folder illustrates and describes in concise form the Blaw adjustable steel culvert form, which has recently been placed on the market.

The Highest Reinforced Concrete Water Tank in the World—Blaw Steel Const. Co., Pittsburgh, paper, 6″ x 9″, 12 pp., illust. This booklet is somewhat out of the usual run of sales literature, being a reprint of an article describing the construction of a large water tower having unique features. It contains much information of value on the subject of concrete standpipes.

Current Prices — Concrete Materials

Portland Cement—Prices on cement have in general increased slightly during the last month. Prices given are f. o. b. cars at points named, including cloth sacks, for which, in general, 40 cts. per bbl. (4 sacks) is refunded on return in good condition. Pacific Coast cement manufacturers now allow only 7½ cts. each for bags returned instead of 10 cts. as previously done. This is equivalent to a raise of 10 cts. per bbl. in price. Prices per bbl. (including four cloth sacks) are as follows: Boston, $1.87; New York, $1.67; Chicago, $1.81; Pittsburgh, $1.81; Cleveland, 1.94; Cincinnati, $1.79; Detroit, $1.90; Indianapolis, $1.94; Toledo, $1.94; Milwaukee, $1.93; Minneapolis and St. Paul, $2.08; Duluth, $1.96; Peoria, $1.89; Cedar Rapids, $2.00; Davenport, $1.90; Denver, $1.87; Toronto, $1.75; Montreal, $2.00; Winnipeg, $2.60; Vancouver, $2.75; Spokane, $2.35; Seattle, $2.30; Portland, Ore., $2.40; Tacoma, $2.30; San Francisco, $1.90; Kansas City, $1.82; Omaha, $1.98; Oklahoma City, $2.09.

Crushed Stone—1½-in. stone, prices per cu. yd., f.o.b. cars in carload lots, unless otherwise specified. New York, 85 cts., in full cargo lots at the docks; Chicago, 85 cts.; Winnipeg, $2.50; Vancouver, $1.50; Spokane, $1.00; Portland, Ore., $1.15; Seattle, $1.50; San Francisco, $1.15.

Gravel—Prices given are per cu. yd. f.o.b. cars in carload lots unless otherwise noted. New York, 80 cts. in full cargo lots at docks, Chicago, 85 cts.; Winnipeg, $1.85; Vancouver, $1.50; Spokane, $1.00; Portland, Ore., 85 cts.; Seattle, 75 cts.; Tacoma, 75 cts.; San Francisco, 1.00.

Sand—Prices are per cu. yd. f. o. b. cars in carload lots unless otherwise indicated. New York, 45 cts., full cargo at docks; Chicago, 85 cts.; Winnipeg, $1.85; Vanouver, $1.25; Spokane, $1.00; Seattle, 75 cts.; Portland, Ore., 85 cts.; Tacoma, 75 cts.; San Francisco, $1.15.

Reinforcing Bars—The difficulty of placing orders for bars is increasing daily and to all indications the time is not far off when it will be impossible to obtain any large orders The prices here given are only approximate since they fluctuate greatly and few mills are taking business even at the figures given. At the present time practically all businesss is being taken on a basis of $2.75 per cwt., Pittsburgh, with prevailing extras for bars under ¾″ or base, and for delivery in 6 mos. to 7 mos., except in special cases, where a premium is paid. The following are quotations on base bars per 100 lbs., for mill shipments from other points, f. o. b. cars: New York, $29.19; Philadelphia, $29.09; Chicago, $29.89; Spokane, $3.05; Portland, Ore., $2.70; Seattle, $2.70; Tacoma, $2.70.

Shipments from stock are being made at the following prices per cwt. f. o. b. New York, $2.95; Buffalo, $2.95; Cincinnati, $3.20 to $3.75; Cleveland, $3.25; St. Louis, $3.15; Chicago, $3.10; St. Paul, $3.20; Toronto, $2.50; Spokane, $3.95; Portland, Ore., 3.$60; Tacoma, 3.60; Seattle, $3.60.

Metal Clips for Supporting Bars—$4.50 to $6.50 per 1,000, depending on size.

For the majority of the prices given we are indebted to the Universal Portland Cement Co., Concrete Steel Co., Dewey Portland Cement Co., American Sand & Gravel Co., Chicago, and F. T. Crowe & Co., Seattle, Portland, Spokane and Tacoma.

Reinforcing bars for mill shipments are in general sold on a Pittsburgh basis: that is, at the Pittsburgh quotation plus the freight to the point in question, and with the following list of freight rates on finished material and the Pittsburgh quotation given, the price of bars at any of the points listed can be readily computed.

From Pittsburgh, carloads, per 100 lbs. to:

Albany	16.9 cts.
New York	16.9 "
Philadelphia	15.9 "
Baltimore	15.4 "
Boston	18.9 "
Buffalo	11.6. "
Cleveland	10.5 "
Birmingham	45 "
Cincinnati	15.8 "
Chicago	18.9 "
Denver	68.6 "
St. Louis	23.6 "
New Orleans	30 "
Minneapolis	32.9 "
Indianapolis	17.9 "
Kansas City	43.6 "
Omaha	43.6 "
Pacific Coast Points (Rail)	73.9 "

Now that the Panama Canal has been opened to traffic ocean freight rates on reinforcing bars to Pacific Coast points have been established which materially lower the delivered cost of bars from the east. The rates per 100 lbs. to Pacific Coast points for large lots are. From Pittsburgh, 61.9 cts.; Chicago, 76.5 cts.; Youngstown, 61.9 cts.; New York, 40 cts.; Bethlehem, 52.9 cts.

Concrete

Vol. 8 *Detroit, May, 1916* *No. 5*

Again the Demon Wood Shingle

AGAIN the wood shingle has upheld its record as the greatest single agency in the spread of fire. In the recent conflagration at Paris, Tex., Mar. 21, the shingle roofs served as so many beds of kindling, needing only the wind-driven firebrand to scatter the fire far beyond the reach of the fire-fighters.

State Fire Marshal S. W. English says in his report:

> A most important lesson to be drawn is the hazard of the shingle roof. Modern history does not contain a more perfect example of the conflagration hazard than is present in every city or town where the shingle roof is prevalent. The burning of the business district of Paris was not due to a lack of fire fighters; it was not due to a lack of water; it was not due to the construction of the business district itself, but was primarily attributable to the shingle roofs of the residence section of the city. The firemen were not able to hold the blaze to the first building being burned, for the reason that the brands carried by the high gale had set on fire buildings, four, five, six and even 10 blocks away and, in practically every instance, the fire started on the roof of the building. Those in turn, would send their burning brands on the wings of the wind to other buildings with shingle roofs until every dwelling on both the south and the east side of the business section was a seething, roaring mass of flames; and, notwithstanding the fact that the roofs of the business buildings had refused to take fire from the burning embers that had fallen upon them like a rain of hail for some time, when the half-circle of fire around the business district had closed in, the intense heat of the wood-driven flames and the flying brands and coals which were many inches deep in the streets broke through the windows and doors and, when once an entrance was effected, the doom of the business section was sealed. Had the roofs of the dwellings in the path of the fire from its point of origin to the business district been of non-combustible material, it is believed that the fire department of Paris alone could have easily held the blaze to at least the block in which it originated.

At Nashville, Tenn., the wood shingle again enacts the role of the villain, for, according to the *Western Underwriter:*

> About 500 residences were destroyed; some of these were in the negro quarter and others were of small value, but there were large numbers of valuable residences that were consumed. One of the features of this section was the almost universal use of non-combustible roofs.

It appears that in this section, where most of the residents had provided for a reasonable amount of protection, the carelessness of the few carried disaster to the entire neighborhood.

No one who has witnessed a conflagration can fail to realize that no house as commonly built can withstand the terrific heat if directly in the path of the fire. On the other hand, houses with fire-resisting walls and roof will seldom be ignited by brands and are easily protected. It is plain that during the progress of a great fire one dry shingle roof in a group of fire-resisting houses can result in the destruction of the entire group. Under present conditions the wood shingle is not only a fire menace but it is not economical.

How the Study of Roads Has Helped

THE development of the concrete road has done a great deal for other branches of the concrete industry, besides what has been accomplished for taxpayers and humanity in general. The problems presented in road building were acute and their solution developed information about concrete which could not have become available so soon had it not been for a necessity presented in paving, where the vulnerability of the material improperly put down was a more serious matter than the same quality under other conditions. A road requires the best of concrete. In the early days of concrete roads, much was said about expansion and gradually the talk has turned almost entirely to contraction. There has also been less and less talk of temperature effects and more and more talk of moisture. Now it gets back to that fundamental of all good concrete—density. The Bur. of Standards took measurements to determine change of dimension of concrete on a test road on the bureau grounds and also on the Coleman-du Pont Road at Millsboro, Del.

> The results thus far confirm those previously obtained by the Bureau on the New Village, N. J., and Nazareth, Pa., roads—that in the winter and the spring there is an expansion of the concrete caused by increase of moisture content and in the summer a marked contraction caused by loss of moisture. This is contrary to the generally accepted opinion that concrete expands most in mid-summer and least in winter.

Grade your aggregates; use enough cement; mix them thoroughly and long; cure the product carefully. Make concrete that keeps the moisture out.

The Workman and His Tools

IN a letter to this magazine a concrete worker who specializes in work requiring the services of skilled finishers, says:

> A good carpenter prides himself on having a good set of tools, but the cement worker tries to see how few tools he can have and get along. If you show him a tool better than the one he uses he will tell you he has one that will do. Most cement workmen buy new tools only when forced to do so.

This man was speaking of the workman, particularly the cement finisher; it is true that, as compared with other trades, the tools required by the cement worker are few and inexpensive, but it is also true that such tools as he does use receive exceptionally hard usage. Perhaps this fact has made him reluctant to own more tools than are absolutely necessary.

These facts naturally lead to a consideration of the concrete contractor. How far is the same attitude reflected in his equipment? The profit in concrete construction cannot be made on the material; it must come from efficiency in handling the work. The question as to whether or not a given piece of equipment will produce a profit is one that must often be settled and from that decision often depends the profit that will be taken out of the job. Never in the history of the industry has there been available so great an array of equipment suited to every need of the contractor. If your work suggests that special equipment might be made to turn a profit, CONCRETE will gladly help to find it.

Concrete Floors in the Home

THE human race is in the main extremely conservative. It has a rooted objection to the exchange of an old idea for a new one. Part of this is mental lethargy. For instance, there is the concrete floor. When it is fully appreciated how much more durable, sanitary and fire-safe concrete floors are than a wood floor, there will be more of them. When it is learned that a concrete floor may be beautiful there is nothing to stop its adoption. Readers of CONCRETE will remember what Homer J. Laughlin, Jr., said[1] about the concrete floors in his house in Los Angeles. Irving J. Gill, the architect largely responsible for the work, dilates enthusiastically on concrete floors in residences, in an article in the *Sunset Magazine*. He says in part:

> To overcome the popular prejudice against concrete floors is the business of the architect. There are certain definite conditions to be observed in laying concrete floors. They are fundamental and in their strict observance lies the answer to the charge of the physical discomfort of concrete. After practical objections are overcome, attention may be given to esthetic considerations.
>
> Concrete floors are usually laid free from the ground, with a dead air space underneath. In most of my houses the concrete floors are laid directly on the ground (in California) doing away with air circulation under the floor and giving a more equable temperature. They are raised at least 21″ above the surrounding ground, and particular attention is paid to the preparation of the earth bed. After the foundation is laid the ground is puddled and tamped until very firm. Over the surface is spread from 4″ to 6″ of sand or sandy loam. Then the concrete is put on. If one part of the floor is below grade, the ground under it is carefully drained, after which the layer of sand prevents moisture from coming through.
>
> The main body of rough concrete should be reinforced to ⅓ of 1% to prevent cracking, and scored to give a key to the top coat and prevent its loosening from the bottom. The finish coat should be reinforced with No. 18-ga. ½-in. mesh galvanized wire to prevent cracking.
>
> From 4 wks. to 6 wks. should be allowed for concrete floors to dry. During this time there is a continuous process of absorption and radiation of heat until a mean temperature has been reached, after which the temperature of the floor is more equable than that of wood.
>
> To cover a concrete floor with wood is about as logical as to cover concrete sidewalks with boards. Everybody who has lived on concrete floors laid according to the given specifications has been wholly converted to them and would never again be bothered with the care and trials of wood floors. It is not, of course, expected that concrete floors should be left bare. They should be partly covered with rugs, the same as a polished wood floor. Incidentally, when properly laid, waxed and polished, cement floors are ideal for dancing.
>
> When troweled and finished to a gloss, concrete floors do not mar or scratch. They should not be scored or marked off into squares or designs. The natural crazing of the top coat is far more pleasing. I have found no cement floor paint that produces a good effect. The hard, monotonous flat colors are unpleasing, the paint soon wears off and shows the cement. Instead of using paint, I mix color with the cement, usually tones of red and yellow, red and brown or yellow and brown slightly mottled. Tempered by the gray of the cement, these colors produce neutral tones that are a splendid background for rugs and furniture. When quite dry, the cement should be cleaned with a weak solution of ammonia and water, given two coats of Chinese nut oil to bring out the color, then finished with a filler and waxed like hardwood. Well done, this treatment gives an effect of old Spanish leather.
>
> It is quite as impossible to tell how to lay and finish a concrete floor to bring out all its potential beauty as it is to give exact rules for painting a picture. Specifications and instructions carry one just so far, but beyond that point each builder must study out the problem for himself. It takes the knack or the inspiration or the gift—whatever its name—that differentiates craftsmanship from mere mechanical perfection, that raises the artist above the artisan, to make a concrete floor the thing of beauty it can and should be.
>
> Before it has set, cement is a wonderfully plastic material, more wonderful than clay. It can be colored, modeled, shaded and surfaced, and then of itself hardens into an overlasting expression of the workman.
>
> The protest against ordinary concrete floors is the unconscious demand for the thing well done. At heart we are never satisfied with any work that is not done right, and concrete floors will not come into their own until architect and workman study them as an art.
>
> The cement floors in the home of Homer Laughlin, in Los Angeles, forecast the possibilities of the future. Sprawling there, his soul in his work, with great sweeps of his trowel an artist wrought in that plastic, responsive material, blending the colors marvelously in the broad central spaces, coaxing them to a rare harmony of tone and exquisite finish, and around the outer edges he carved in low relief the lines of acanthus and other simple conventionalized leaf forms. In the entrance hall, with big, free strokes he limned the feather-like fronds of a palm, using his color with consummate skill and an artist's feeling. The appeal of this most modern manifestation of ceramic art is far more subtle than that of the mosiacs, which were the acme of floor-making among the Greeks and Romans, and it has the singular advantage of being within reach of beauty lovers of moderate means.
>
> Concrete floors are cheaper than wood for the first story; they are enduring, they require a minimum of care, they are comfortable and healthful when laid right, and they can be more beautiful than any other floor.

In the presidential address before the English Concrete Institute, Henry Adams takes exception to some of the statements of R. S. Greenman in reference to concrete failures made at the annual meeting of the Am. Soc. for Test. Mat. at Atlantic City, N. J., last year. He says, in commenting upon Mr. Greenman's remarks:

> The best way to have the engineering profession strengthened is to prevent inferior or bad engineering work, and the best way to accomplish this is to tell freely what proves successful and what proves unsuccessful, so that everybody may profit, so far as in him lies, by the knowledge of all. No engineer will lose standing among his colleagues or be ranked any less competent by business men for frankly putting on record a statement of his non-successes. On the contrary, he will receive the approbation of all thinking men, for he will warn others away from a repetition of his unsuccessful work, which is a most desirable thing.

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[1] Concrete, Jan., 1915, issue, p. 41

Methods and Cost of Constructing a 60-in. Reinforced Concrete Sewer

By E. W. Robinson, C. E.[1]

The September, 1915, issue of CONCRETE *published data on the cost of constructing a 42-in. and a 48-in. concrete storm sewer in San Antonio, Tex. Following is a description of the construction of a 60-in. reinforced concrete sanitary sewer by the same company a few months later in the same city. A comparison of the sketches shows similar design of the sections except where the sewer here described is laid over filled ground. In this case the bottom is increased in thickness and extra reinforcing steel is added so that the barrel acts as a beam between piers which go down to solid earth. It is believed that the following data will be of interest in affording a comparison of costs on two jobs which are similar and which were handled in practically the same manner.*

The 60-in. sewer here described is approximately 1,300′ long, in two sections, one on either side of the San Antonio River, in San Antonio, Tex. This line is part of the main outfall sanitary sewer for a large part of the city. Where the sewer crosses the river and the ground is subject to overflow it is to consist of a riveted steel pipe supported on concrete piers. The longer section, about 1,000′, is on the north side of the river and connects the steel pipe line with a vitrified clay segmental block line. On the south side of the river the remaining 300′ connects the steel pipe line with the 72-in. reinforced concrete main outfall for the whole city. On this side the whole length is below the surface of the ground, while on the north side part of the sever is exposed the whole distance, varying from a few inches of the crown down to the springing line. About 300′ next to the steel pipe line is entirely off of the original ground surface, as is shown in Fig. 1, which also shows the relation of the new sewer to the existing 36-in. brick sewer.

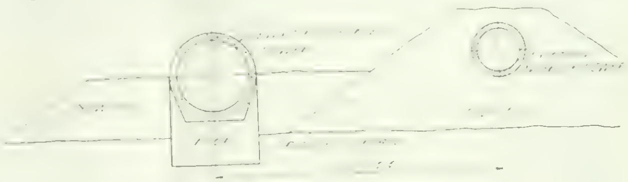

Fig. 1 Diagram of Location of Sewer

CONSTRUCTION METHODS

Owing to insufficient right-of-way, brush and other obstacles it was decided at the outset to place the mixer and all material for concrete, except cement, on the crown of the embankment over the existing sewer. This was advantageous in placing the concrete as it could all be chuted into place, whereas if the mixer had been placed on either side it would have been necessary to wheel all concrete up an incline to get it into the forms. The worst trouble with the method adopted came from insufficient room for placing the proper amount of aggregate and for wheeling to the mixer skip, as the crown averaged only about 6′ wide at the top of the embankment. To place sufficient gravel and crushed stone to make 10.2 cu. ft. of concrete per lin. ft. of sewer meant that the piles had to be about as close together and as high as was possible to make it stick on so narrow a width when unloading with bottom-dump wagons. Also, from the fact that the material piles were so high and close together it was difficult to bring additional quantities of either aggregate to the mixer when they happened to run short, and care was taken to get the stone and the gravel apportioned as closely as possible to exactly what was needed.

Both gravel and stone were hauled by sub-contract so it was necessary to keep one or two men on the embankment all the time cars were being unloaded to see that all wagons were filled evenly and that the proper number of loads were dumped in each place. These men also kept the slopes cleaned of material that was knocked down the sides every time a wagon turned off the dump or drove over piles where more than two loads had been placed together. Even with this extra care and expense one or the other of the aggregates would run short occasionally and considerable was wasted.

Water for the concrete was secured from T's in a $1\frac{1}{4}$-in. line laid along the toe of the slope of existing embankment on the opposite side from the new sewer. These were placed about 80′ apart and a 50-ft. section of hose or pipe was all that was necessary to connect with the mixer. At first a good quality of rubber-lined cotton hose was used but the excessive water-hammer from sudden opening and closing of the throttle valve at the mixer soon destroyed it. The next method employed was to run the pipe line within a few feet of the mixer and connect up with a short piece of steam hose, but this soon gave way, especially at the connections. The method finally chosen to avoid wasted water and a wet place to work in around the mixer was to connect the pipe direct to the mixer, which was done although it cost much more than the other methods. The same trouble was experienced on the job described in the Sept., 1915, issue, but in a lesser degree. On that job the pressure was directly the cause of the trouble as the mixer was always within 100′ or so of a fire hydrant to which connection was made. On the present job the pressure was lower and the excessive water-hammer was caused by the valve opening at the mixer being the same size as the whole 2,000′ of pipe line.

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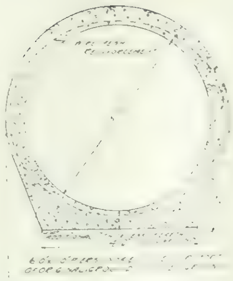
[1] Chf. Engr., McKenzie Const. Co., San Antonio, Tex.

On this job it was necessary to use outside forms because so much of the concrete was above the surface of the ground. One section about 30″ wide and 14′ long was used on each side of the sewer. They were made of 1-in. x 4-in. flooring nailed to 2-in. ribs cut to proper curvature and spaced 4′ o. c. These forms were held in place by braces nailed to stakes driven in the ground far enough from the sewer to keep from caving the banks.

As shown in Figs. 2 and 3, where the sewer was off of the original undisturbed ground the bottom concrete was increased in thickness by 1″ and extra steel added to produce a beam effect between piers. The piers were spaced 10′ o. c. along the axis of the sewer, and were 6′ wide, 12″ thick and not reinforced. They went down to a depth of at least 2′ below the original ground surface. After the excavation had been finished to proper cross-section and grade for the barrel of the sewer the pier holes were excavated to neat size and filled with concrete to 1″ above subgrade, thus dispensing with forms. The 1-in. projection served as a support for the 5/8-in. bars. The rest of the sewer was poured as a monolith as described in the previous article.

COSTS

The average rate per hr. paid was about $.23, being $.22 and $.25 per hr. for all but two men and the foreman on the job. The man who ran the mixer and looked after changing the pipe line, etc., was paid $.45 per hr. and the leader setting forms was paid $.30 per hr. One gang did all the work and 19 men and a foreman would under average conditions pour 320′ of concrete per wk. of 6 working das. The whole of the forenoons and part of the afternoons were taken up with excavation, setting forms and moving mixer, and the rest of the afternoons were spent pouring the concrete. The same kind of steel forms was used on this job as on the other, except that they were made of heavier material to make them more rigid under increased size. In this case they could not be held down by trench jacks as before, so they were weighted by means of sacks of earth on the inside. A steel channel track in 20-ft. sections, resting on the rings of the forms, and a small push-car were used to transfer the sacks back and forth. This method worked fairly well, and where the sewer is large enough to enable the men to work comfortably and where the trench does not have to be braced to keep it from caving it is believed that the inside method is the cheaper and more satisfactory.



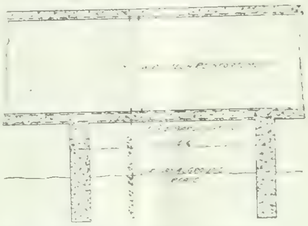


Fig. 2—Section of 60-in. Sanitary Sewer

Fig. 3—Longitudinal Section in Made Ground

Excavation was all done by hand and the actual cost for same was $.326 per cu. yd. There was an average of about .85 cu. yd. per lin. ft. of sewer.

The actual cost of setting outside and inside forms and placing wire mesh reinforcing after it had been tied was $.138 per lin. ft. of sewer.

The actual cost of mixing and placing concrete was $1.018 per cu. yd., and there were .38 cu. yds. per lin. ft. of sewer proper. This includes all cost of moving mixer, pipe lines and runways, and also all cleaning up and rearranging piles of gravel and crushed stone. The cost of moving mixer, pipe line and runways alone was $.236 per cu. yd.

The main reinforcement was 4-in. x 8-in. mesh of No. 0 and No. 5 wires, respectively, of Clinton electric weld wire mesh.[2] This weighed 0.9194 lbs. per sq. ft. and was bent and tied as described in previous article. The cost of bending and tying was $6.10 per ton. The reason for the increase in cost of $1.56 per ton over that on the other job was due to there being such a small amount and to the fact the men were new at the work. They barely got organized well before bending was all done. It is true that the wires were somewhat heavier and harder to bend, but the increased weight obtained from each sheet bent should more than offset this.

Separate cost of the labor expended on making a perfect finish inside the sewer barrel showed that this item amounted to $.06 per lin. ft. of sewer. On the other job this was considered as a part of placing concrete, and the reason why it was separated on this work was because this line was a sanitary sewer with a grade of only .08 of 1% and it was expected that the cost would run much higher than it did.

SUMMARY

This work was done by the same foreman with practically the same gang and equipment that did the other work, and the writer considers that the costs check remarkably well. The lower cost of excavation and setting forms was due partially to less depth below ground surface. The whole of the reduction in mixing and placing concrete, as well as part of the reductions on excavation and forms, was due both to a slightly lower wage paid and to better organization. The latter was secured by using a small gang and so arranging the work that every operation was constantly under the supervision of the foreman. The writer believes that in a great many instances work costs more than it should because the management expects a foreman to superintend more men than he can efficiently handle, especially if they are scattered considerably. The laborer is exceptional indeed who will do as much or as good work with the foreman a block away as he will if the foreman be nearer, even though it appears that he is putting forth the proper effort.

Whenever anyone writes or talks about cement, the first starting point is always Rome and the cement that the Romans made which stands for all that there is of permanence and durability. Rome and the Romans, however, have not been standing still in all these days in the development in the use of concrete and according to a booklet recently issued by L. Luiggi, Prof. of hydraulic construction at the University of Rome and Inspector-General of the Royal Italian Engineers, the Corso Victor Emanuel in Rome, one of the most important highways of that city, is covered with concrete made of "soliditit" cement which wears like an immense slab of granite and that other concrete roads are being made with the special cement, "giving extraordinary hardness to the concrete and imparting resistance to wear equal to granite."

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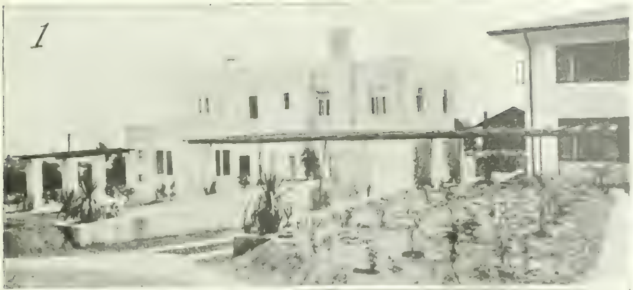
[2] Clinton Wire Cloth Co., Clinton, Mass.



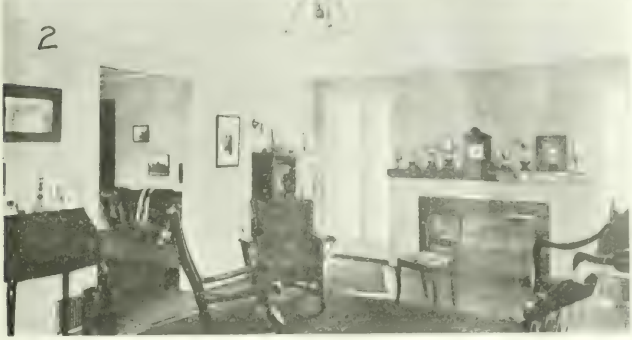
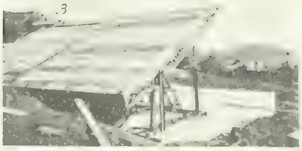
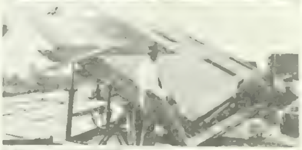
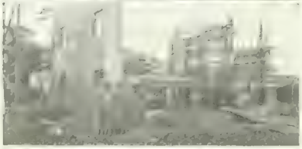


FIG. 1—CONCRETE HOUSE WITH PRE CAST WALLS AT HOLLYWOOD, CAL.
FIG. 2—INTERIOR, SHOWING CONCRETE AND TILE FIREPLACE
Note the sanitary finish of door and window openings and absence of wood trim







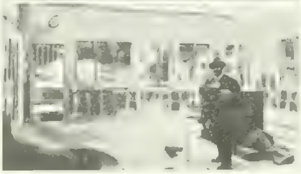


FIG. 3—FORM READY FOR CONCRETE
FIG. 4—READY TO RAISE A WALL SECTION
FIG. 5—THREE STAGES OF CONSTRUCTION
At the left a wall is in position. At the right the wall has just reached its place, while in the foreground a form is ready to receive the wall
FIG. 6—WALLS READY TO PLASTER

A Concrete House with Pre-Cast Walls

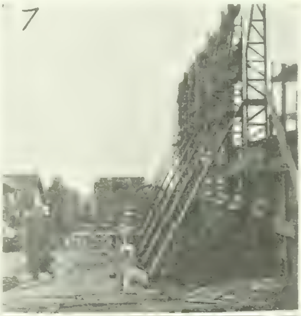
Early in the history of concrete construction, Col. Aiken, U. S. Army, devised a system of casting the walls of buildings in a horizontal position and raising them with special equipment. Numerous buildings were erected, notably at army posts, but the system was not widely used. Recent developments indicate increasing interest in the possibilities of this plan, one of which was recently described.[1]

In the construction of a concrete house at Hollywood, Cal., the walls were pre-cast in a horizontal position and raised by motor-driven jacks. The house was designed by Irving J. Gill[2] and erected under his supervision.

After the foundation for the house had set the floor slab was laid and on this jacks for the erection of the walls were placed, which are well shown by Figs. 3 and 7. Twelve feet of floor space from the wall to be erected was required in which to place the jacks, on which tilting tables, built of 2-in. x 6-in. rough plank, were laid over steel walking beams. The number of jacks used and the spacing of them depended on the weight and size of the wall to be supported.

Door and window openings were laid out, the metal jambs set in place and the remaining surface of the wall form covered with hollow tile spaced for reinforced concrete beams to give proper stiffness; twisted steel rods were then placed vertically and horizontally and the wall was ready to be poured. Concrete was wheeled up an incline, dumped, leveled off and allowed to set. The upper surface (the outside of the wall) was finished in its tilted position before being raised.

The power for erection was obtained from a 5-h. p. gasoline engine and transmitted to the jacks by a shaft through their pedestals. A



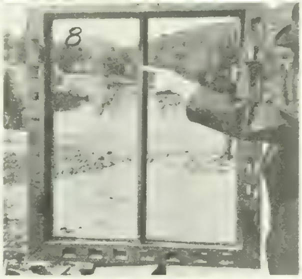


FIG. 7—RAISING EQUIPMENT
FIG. 8—METAL WINDOW FRAME

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[1] CONCRETE, Jan., 1916. p. 41
[2] Archt., San Diego, Cal.

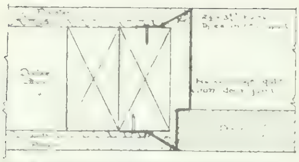


FIG. 9 DETAIL OF METAL DOOR FRAME

worm gear mechanism extended all jacks at exactly the same rate.

From ½ hr. to 2 hrs. was required to raise each wall, the time depending on the weight, shape and position of the wall.

Horizontal rods left projecting from the ends of the walls were bound together after two adjacent walls had been raised to an upright position. A form 2′ wide was built up the entire height of the wall and into this concrete was poured, producing a concrete and hollow tile shell reinforced with twisted steel bars.

CONSTRUCTION DETAILS

Roof joists are held in place by anchors for which provision had been made in the concrete wall and 1-in. x 6-in. sheathing covered by a gravel composition was used for the roofing. Interior partitions are of metal lath on wood studding and the rough concrete floor slab has been covered by a finish coat reinforced with wire cloth.

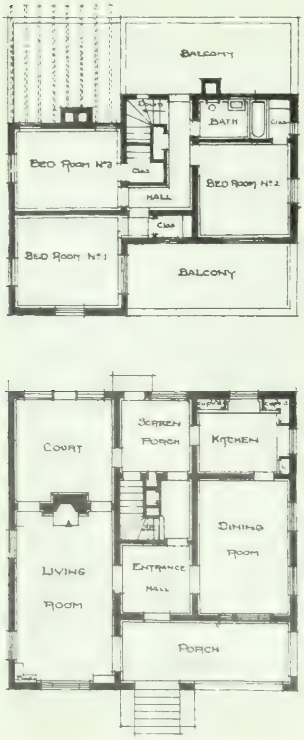


FIG. 10 FIRST AND SECOND FLOOR PLANS

Special metal door and window frames[3] were used manufactured from No. 22 ga. galvanized iron bent to shape and provided with perforated flanges through which the concrete forms a key. The plastering finishes flush to the corners of the frames which act as a corner bead for both exterior and interior wall surfaces. Each side of the frame is bent from one piece of metal so there is no danger from cracks.

Sanitation and fireproofing are the features of the finish as well as the structural details. There are no moldings or panels on the doors, simply plain slab surfaces easily cleaned or dusted, while the absence of baseboards, ceiling beams, plate rails, door and window casings and picture molding makes the house as nearly dirt proof as is possible.

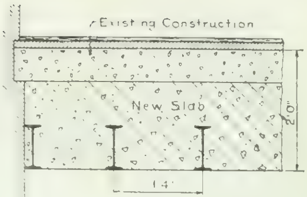
The experience gained in the construction of this house indicates that it has possibilities for economy that will recommend its more extended use.

Bomb-Proof Cellars to Provide Shelter During Aerial Attacks.

Bomb-proof shelters have been constructed in German towns as outlined in the following translation of an article from a German publication.[1] This description of how any ordinary basement room with concrete slab ceiling can be reinforced to resist aerial bombs is especially interesting from the engineer's standpoint in that it gives some idea of the important part concrete plays in modern warefare.

Recently the attacks of aviators on open and fortified towns on the western front have become decidedly more frequent. This is evidenced by the last air attacks on Saarbrucken, Saarlouis, Metz, Diedenhofen, Freiburg, Stuttgart, Karlsruhe and Ludwigshafen. Several towns, especially such as have extensive industrial works, have endeavored to sound the warning of approaching air fleets, wheih are often composed of 15 to 20 aeroplanes, by means of the steam or electric sirens of the large factories. The inhabitants thereupon hasten to the cellar rooms of the nearby houses, where they remain until the attack is over.

All such cellar rooms cannot be considered bomb-proof. This is especially true of thin reinforced concrete slabs of from 12 cm. to 15 cm. (5″ to 6″) thick and cellar roofs in one-story buildings which are easily broken through by heavy bombs dropped from great heights.



DETAIL OF BOMB-PROOF FLOOR

When one considers that enemy aviators in order to protect themselves against defense guns keep at a high elevation—often from 3,000 m. to 4,000 m. (10,000′ to 13,000′)—and further that, especially in sunny weather, an aeroplane is practically invisible because of the sunshine and can be discovered by the eye only after a long search, then only can the momentum of an aerial bomb and the unexpectedness of it be appreciated, against which only a bomb-proof room will protect. For this reason it has been suggested to cover at least one cellar roof of a house with one or more layers of sand bags to protect the room below against bombs and their destructive action. Then again in some cases it has been suggested that bags be placed on flat roofs or on the cellar beams of steep roofs. In both cases a continuous load of sandbags will cause trouble, and also the fact should not be lost sight of that such a covering is not an absolute preventative of damage.

A bomb-proof room can be fitted up in another manner by strengthening the floor over an especially suitable cellar room, from below. In the more modern apartments and residences the thickness of slabs over the basements, incl. of flooring, ranges from 20 cm. to 30 cm. (8″ to 12″). If a reinforcing slab about 40 cm. (16″) thick is placed under the original slab so that the total thickness is at least 2′, a reasonable degree of protection will be insured to the persons taking refuge thereunder. This reinforcing slab can be put in without damage to the existing slab in the following manner: Steel I-beams 8″ to 10″ deep should be placed in the direction of the load-carrying span of the existing slab in such a manner as to leave a space of from 15 cm. to 20 cm. (5″ to 6″) between the under side of the existing slab and the top flange of the beams. The spacing of the beams should not be greater than 40 cm. (16″), for the closer the spacing the better will the purpose be fulfilled. By building a wooden form under the beams or by placing steel plates on the lower flanges the space between two beams can be filled with plain concrete, every succeeding beam being laid only after the space between the two preceding beams has been concreted.

The expense of such a construction should not exceed $2.50 to $3.00 per sq. m. (0.84 sq. yd.), or a total of $40 to $60 for a fair sized basement room.

Columbia University will hereafter confer the degree of Master of Science upon graduate engineering students who complete the course in Highway Engineering. Between 1911 and 1915 the students have been candidates for the degree of Master of Arts.

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[3] Patent applied for. Irving J. Gill

[1] *Baumaterialien Markt*, Leipzig, Nov. 26, 1915

Stairs Cast in Separate Units for Boston Transit Commission

By W. B. Conant

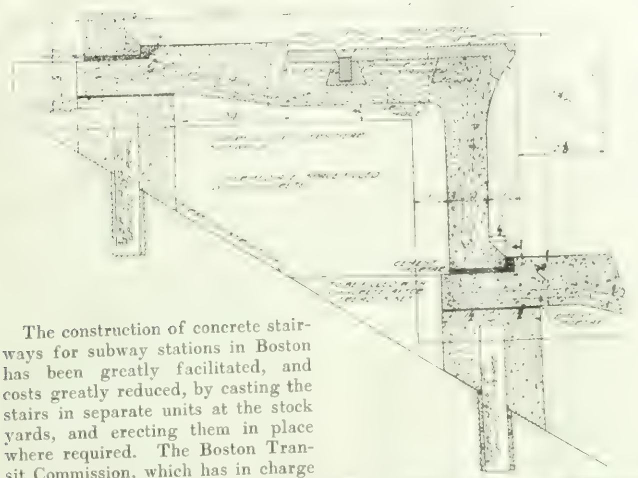


Fig. 1—Detail of Pre-cast Stair Construction

The construction of concrete stairways for subway stations in Boston has been greatly facilitated, and costs greatly reduced, by casting the stairs in separate units at the stock yards, and erecting them in place where required. The Boston Transit Commission, which has in charge the building of tunnels and subways in that city for rapid transit lines, maintains a yard at C and Cypher Sts., South Boston, where reinforcing rods, waterproofing materials, cement, structural steel, sewer and grouting pipes, etc., are kept on hand in quantities and furnished to the contractors. The Commission's own employees, however, cast the stairs and other structures used in finishing the tunnels, this work being in charge of Asst. Engr. Philip B. Walker. An average force of 56 laborers and two crane operators is employed at the yards.

Under the former system of stairway construction, a form had to be erected for each flight, and in removing the form much of the lumber was destroyed. Consequently the plan was worked out to cast each stair as a unit, a reinforced tread and riser being cast together, one or more units making up the full width of the stairway. The units are mostly in 8-ft. lengths, this being the typical single stairway width, while double stairways take two lengths, there being a railing to separate them. Practically all the stairways in the Washington St. station of the Dorchester Tunnel have been cast in this way, and a few were used in the earlier Boylston St. subway.

One difficulty of casting the stairs monolithic was the difficulty of getting the concrete tight against the iron base plate or tread, which caps each stair. In hardening, the concrete receded slightly from the under side of the plate and when walked upon the stairs gave the effect of being hollow.

The new plan of casting is as follows: A cypress form of sufficient length to carry two 8-ft. lengths is used to give the face of riser and tread; i. e., the stair is cast in an inverted position. The base plate, 7″ wide by ⅜″ thick, to which a corrugated "safety tread" is attached, is laid face down on the form. Reinforcement consisting of ¼-in. deformed bars, as indicated in an accompanying illustration, are placed in position; lateral rods bent to conform with the elbow of the unit are spaced at about 2-ft. 6-in. intervals in the length and wired to the longitudinal rods, the reinforcing being cast ¼″ from the outer surface.

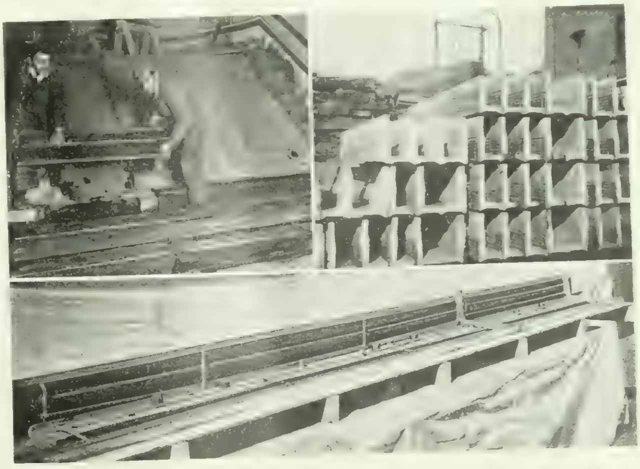
End bulkheads are set in position and over these is placed the form for the back and the under side of the unit. This is screwed to the bulkheads.

Then the form is filled with a mixture consisting of 1 part Newburyport sand, 1 part cement, 1 part stone dust, ¼″ diam. and finer, and ½ lb. lampblack, the materials being measured by volume. Standard stairs are of 7-in. riser and 11-in. tread, with tread 1½″ thick and riser 1¼″ thick.

As the concrete sets, the form is carefully troweled off to a finished surface, it being necessary to get an absolutely uniform thickness.

The unit is allowed about 24 hrs. to set; then the front form is removed and the riser finished. After one more day, the unit is turned over and the tread finished. Each stair is allowed to cure at least one week.

Preliminary to erecting, a flight of concrete stringers is cast against either wall, and for a wide stairway another stringer in the middle, each 8″ to 12″ wide. The practice is to



Figs. 2-4—Unit Being Set in Place; Stair Units Piled in Yard; Placing Reinforcing

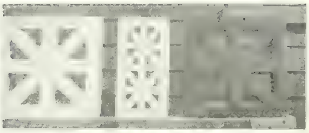


Fig. 5—Reinforced Concrete Ventilator Openings

snap a chalk line on either wall for a nosing line, and to set each unit to this, beginning with the bottom stair. Units are laid in a 1:1:1 mortar and where conditions make it necessary the spaces under the stairs are grouted with a similar mix through holes 1½″ in diam. cast in the treads by means of pipe sections. Otherwise, if the space beneath the stairs is accessible, the space is concreted from below.

All external stairs, leading to the street and exposed to the weather, are cast with a gutter along the back surface of the riser, 1⅜″ wide and ½″ deep, pitching to either end, whence it leads to the front edge of the stair. These gutters provide a means of draining the drip from shoes and umbrellas, and lead to a drain at the landing or foot of the stairway.

Units are hauled an average of about 1½ mi. to the work, it being found that with the adequate reinforcement provided, no injury is suffered in transportation. Each stair weighs 300 lbs. to 350 lbs. and can be handled by two men.

The cost of casting the units, exclusive of the base plate and tread, and delivering them to the work, is found to be about 50 cts. per lin. ft. This is 33% to 50% cheaper than constructing the stairways on the job. In addition, the Transit Commission's force casts reinforced ventilators, drain and hatch covers. Specimens of ventilator openings, one with brass wire grill, are shown in an accompanying illustration.

The design of the new type of stair construction was worked out by L. B. Manley, asst. engr. to the Commission.

It is a generally accepted fact that rich cement mortar will bond to a concrete surface provided the surface is cleaned and the aggregate exposed. When joining surfaces in compression the old surface should be cleaned, roughened and wetted. When joining surfaces in tension the wet and rough surface should be coated with rich mortar before new concrete is placed.

Method of Handling a Concrete Job

To show briefly the intricacy to which it is necessary to go to get economical results in concrete building construction, Leonard C. Wason, C. E., pres., Aberthaw Constr. Co., Boston, in an address before the Natl. Assn. of Cotton Mfrs. told how a builder in reinforced concrete after long study, has settled upon a type of form which long experience has shown the men can build quickly and economically. He says:

Plans of the forms are made to fit the particular building, with as much precision as structural steel is laid out in a bridge shop. Panels for columns and beams are drawn out, showing the number, width of boards, the number of cleats, the position and even the size and number of nails. The first use is located and the second use, when taken down, is planned from place to place through the building, until finally it reaches the storage pile for removal from the site of the finished structure. From these plans the bill of material is scheduled, and when received the material is put in piles prearranged, and shown on a ground plan of the lot.

A routing department is established and the materials are moved by written orders and taken to the saw-mill, where they are cut according to written instructions and moved to benches. Here they are made up from blue prints and are from there taken by instruction to the building, where the experienced carpenter foreman, who is now given freedom to do only that for which he is especially trained, namely, directing his men, sees that the men assemble the work in place with the fewest possible motions and least effort. This seems and is elaborate, but the results are what count.

Although lumber has doubled in price in the last 15 yrs., the cost of lumber per sq. ft. of floors has not increased; and although labor has practically doubled in price in 15 yrs., the cost per sq. ft. of floors, including all the overhead of making plans, running a routing department, etc., is less than half of what it used to be. This applies as well to reinforcing metal as to forms, and somewhat to the placing of concrete. The greatest savings are obtained where the men work in small units, in pairs, as do carpenters, rather than in the large units necessary in mixing and placing concrete.

It has been supposed that laying brick has been so well established that few if any savings could be made upon it. But by a study of methods for the past year or two, and the application of the principles of scientific management and somewhat those of the task and bonus system, the cost of brickwork has been reduced several dollars per M. without the slightest sacrifice in quality. This gives the very great advantage of planning the work to be done at a certain speed and place, and enables all the other trades and sub-contractors to co-ordinate their work to a definite schedule, thus saving in time and expense.

Cost-Keeping System in Concrete Work—An accurate and detailed cost-keeping system is installed on the job, and daily costs are prepared for the use of the job superintendent. Before 9 a. m. each day, he has the complete record of yesterday's costs, and immediately goes upon the work to straighten out the cost of those items which may be high. Charts are placed on the wall, where at a glance it is seen whether the actual work is running above or below that which it was estimated that it should cost before the work started.

The sub-foremen and gang bosses take a keen interest in watching these, which leads them to think and work for low costs. The general superintendent encourages them in this, and insists that there shall be no sacrifice of quality to obtain these results. These methods have been amply justified. A dollar spent in the drafting room or cost-accounting department has saved many dollars outside, and the combination of the direct and the indirect cost is much lower than it used to be. This precision also saves in the time of construction.

Speed of Building in Concrete—Assume the very common case in which a manufacturer delays an increase until the last moment, then wants his mill in the shortest possible time. Frequently, orders for a mill are placed before a single plan is made for the building. In a week's time a mechanical plant is collected, the general plans of the building are laid out, the details of the footings and foundations completed, the general method of operation studied out, and a time study of operations made as far as sweeping out the finished building. Material is scheduled and ordered to be delivered in a pre-arranged order and at times as wanted, and in a week from receipt of order the organization starts on the ground.

In general, a four-story mill requires from 3 wks. to 4 wks. for foundation work; the frame will be erected at the rate of a story a week, and in from 4 wks. to 6 wks. from the casting of the roof the job will be finished and delivered. Thus the whole undertaking can be put through economically in 4 mos. as a general average. If greater speed is required it can be made at the sacrifice of economy. Within a few months the writer has erected one four-story and basement mill for occupancy in 62 das., and another, under more trying circumstances in midwinter, in 77 das. The ground area of the building has little influence on the time of construction. This is governed by the height, as one operation must follow another in height; while on plan it is a question of one mixing plant or two or more, and of the number of men to operate them properly.

A new objection to the concrete road, one which was recently raised by a Delaware farmer, is that the tractive resistance on such a highway is so low that the wagon will move faster than the horses. In driving onto a concrete highway from the ordinary sand road, which is prevalent down Delaware-way, the farmer's wagon ran onto the horse, causing the animal to kick out the dashboard and break a basket of eggs. Whether he will sue the horse, the highway commissioner or the manufacturer of the concrete road for his damage is not yet known.

Costs in the Manufacture of Concrete Drain Tile

By Charles E. Sims[1]

This discussion of costs in concrete drain tile manufacture is by a man who has his own experience to back up his figures. They are not "doped out," but are records of what was actually done. Such cost information is of the greatest value to other manufacturers — not as an independent guide, but as a basis for comparison, with a careful analysis of the costs in each individual factory.

A certain factory where concrete drain tile have been manufactured for a number of years has kept close tab on the cost of the various sizes of tile. As it is evident that well made concrete tile are being manufactured in very large quantities in Iowa and adjacent states, the publication of detailed costs will work no harm to individual manufacturers now that the industry has become firmly established. Let no manufacturer think that rival business interests do not know enough of his business to estimate his costs closely. Good may result from the publication of such data if they serve to guide investors in concrete pipe machinery to a proper understanding of the cost of manufacture, or, if it serves to guide purchasers of tile in a proper discrimination against bids too low for a good quality of product.

The cost of concrete tile will be figured on the basis of sand costing 60 cts. a ton delivered to the machinery in the factory—a conveyor; cement costing $1.66 per bbl., sacks deducted, delivered in the factory; and labor costing $2.25 per 10-hr. day—the average per man. The cost of the plant and site will be taken as $25,000, since it has been found necessary to invest such a sum in most factories fitted to make tile of all sizes, 5-in. to 48-in., by machinery. Such a plant conveys the raw material by belt-conveyors, elevators or other mechanical device; screens the sand and crushes the coarser gravel; mixes the cement and sand by a power-driven mixer; delivers the mixed and wetted concrete to the several machines making the different sizes of tile; has at least one machine for small tile and one for large tile; has large curing rooms with some system of carting the tile from the machines to the rooms; operates a steam boiler for power and for curing the tile with steam; has a system of watering the tile while curing; and has other features of a permanent character. Assuming the life of such a plant as 10 yrs. the factory would have to pay off $2,500 per annum on the investment. In view of the fact that the plant may be used after it has ceased making tile in quantities for years, and, that if not so used the machinery may have a substantial value for removal to another location, let us assume that in 10 yrs. the factory must pay off but $20,000 or $2,000 per annum, as an average figure. We must further assume that the plant will run a certain number of days each year—a matter difficult if not impossible to predetermine in any location, but let us assume 250 days. Then the fixed charges from this source must be $8.00 per da. The upkeep of the plant and its machinery will be not less than $5.00 per da. operated; taxes and insurance $2.50 per da.; fuel and oil $5.00 per da.; steam boiler engineer's wages $4.00; interest on a working capital of $30,000—a fluctuating quantity—say $8.00 per da.; discounts, advertising, office expenses, including traveling expenses, but no salaries,—assume $5.00 per da. Now we have the basis for figuring the cost of manufacturing pipe per 1,000 ft., or per ton as is often done, at the factory, yarded.

The plant especially referred to operates or should in the interests of economy have operated a tile machine having a capacity of 4″ to 16″ diameter and a machine of another type having a capacity of 14″ to 48″ diameter tile, both at the same time. The table below gives in detail the cost of cement tile in the factory yard, leaving to come out of the profits the salary or salaries of the management and unforeseen expenses, such as poor accounts, such as any like business is subject to.

Most of the concrete tile factories operating in the Mississippi Valley today have grown from small, experimental concerns — grown, or, through inability to grow when stifled by the keen competition, and by the necessity of public ditches to furnish tile of all sizes in large quantities—and growth through such a period has not been easy. The writer built a factory to care for the demand in the county and immediate vicinity when machinery was a very uncertain factor instead of a dependable feature as the guarantee on it indicated to his inexperienced mind, and had to meet the newly formed demand a year or two later from organized districts for larger tile, larger quantities and better quality, by adding to the plant and to its equipment. Today, the investor in a tile factory should know that machinery dependable for the purpose intended is purchasable. He should know that the nature of the selling end is fixed by a limited local trade in small sizes for lateral lines and by the necessity for bidding on publicly let jobs embracing the furnishing of tile, and, very often, the bid must include hauling and transporting the tile from the factory to the ditch, together with the labor of digging the trenches, laying the tile and filling the ditches.

The cost of transporting tile by team and wagon is often figured at 50 cts. per ton for the first mile hauled and 25 cts. per ton per mile after the first mile. If delivery is possible over favorable roads trucks may be used rather than teams and delivery made at less cost on long hauls but the roads and fields are often so soft during the time of hauling drain tile that teams are necessary. Experienced haulers having tile to haul which have attained half or more of their ultimate strength need break few tile. In shipping concrete tile by rail the smaller sizes must be loaded in cars with sides and loading the tile from the curing yard to the car by means of wheelbarrows, industrial car and track, or horse and cart costs from 50 cts. per ton on the smallest sizes to 35 cts. on the larger sizes—10-in. and 12-in.

Sizes larger than those mentioned are usually loaded lengthwise, tier on tier in pyramidal form, on flat cars at a cost (where the loading track is depressed and the tile rolled from a convenient yard) of 12 cts. to 20 cts. per ton—the larger the tile the less the cost. To these last cost figures must be added the expense of furnishing lumber such as a 4″ x 4″ lengthwise on each side of the car to keep the tile from rolling off. The freight charges must be determined from the published tariffs and to these should be added as part of the expense of shipment an allowance for breakage. That allowance will vary with the distance shipped, the number of transfers and the time of the year. The time of year governs to a certain extent the duration and therefore the expense in curing unless they have been made long before shipment. A manufacturer can almost eliminate this allowance if he does not have to rush shipments. Reinforced tile of sizes 24″ and larger are common now and breakage in shipping and hauling such tile is almost negligible if they have been well cured.

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[1] Pasadena, Cal.

A variable in the cost of drain tile has been due in the past to variations in the proportions of cement and sand. One manufacturer deemed 1:4 a satisfactory mixture, some, I believe, made tile much leaner than that in the beginning; another thought 1:3½ was good enough, but today they are practically agreed that 1 part cement and 3 parts sand are necessary. The old idea that drain tile should be made of porous material has passed and materials so proportioned as to give a dense concrete are required, hence the adoption of 1:3 as a basis. Large tile have walls thick enough to make the use of crushed rock permissible and advisable; in this case some of this material is added to the cement and sand, thus reducing the cost. In the table of cost no allowance has been made for this.

In the factory described from whose operations the costs were derived, the tile 5″ to 16″ are, or should be, made by a machine operating with a revolving and upward-traveling "packerhead," a method of operation which presses the damp concrete outward against a steel mold and which at the same time trowels the inside surface of the tile. These tile are mostly used for laterals and should be made in short lengths—12″ to 18″. The larger sizes are made in 2-ft. or 3-ft. lengths with a machine which tamps the concrete by rapidly delivered blows of two mechanical tampers to which the concrete is fed in a regular stream as the steel molds, for the inside and for the outside of the tile, revolve. The larger sizes must be reinforced with wire if the tile are to go into deep trenches and a system has been devised for this which is well known and the cost data given cover the reinforcement as ordinarily used.

Concrete Failures

An English writer on concrete failures refers to R. S. Greenman's paper which was read in this country some time ago and, differing with that writer's experience as to the small number of failures, he goes on to give his own experience on the subject. In so doing he states:

> Of four failures in Scotland which have come under my notice, the following have been the reasons:
>
> 1. Concrete Bins—Bad design, bad workmanship being a contributary cause. 2. Concrete Roof—Bad design. 3. Concrete Tank—Bad design, bad workmanship a contributary cause. 4. Concrete Roof—Carelessness and want of proper supervision, centering drawn too soon.
>
> Mr. Greenman does not seem to have struck any bad design, and this seems to me most remarkable, as my firm finds itself very frequently competing against designs which, on examination, show the margin of safety to be 1¾ to 2.
>
> Some of those low margins are due to want of appreciation of the fundamental principles of engineering, some to systematic skinning of quantities, and others to an unfortunate combination of both those faults.

The writer strikes the key-note of many of the difficulties that were met in the early days of concrete construction in this country. Rapidly, however, owing to the co-operation of the various engineering Associations in the committee on Concrete and Reinforced Concrete and owing to the recognition of proper principles and proper responsibilities, Mr. Greenman's experience as to the few failures due to bad design has been justified in American practice. It must not be forgotten that while France and England were practically ahead of us in the pioneering of concrete and reinforced concrete construction, the fact remains that when American engineers and contractors took up the subject they made rapid progress and, owing to the enormous development of the art proper, rules and regulations early became necessary, and to this much of the safety in concrete construction in America is now due.

MANUFACTURING COSTS OF CEMENT DRAIN TILE

Inside diam. of tile	Feet made per da.	No men employed at plant	Labor cost per da.	Weight of tile per ft., lbs.	Bbls. of cement per da.	Cost of cement per da.	Tons of sand required	Cost of sand per da.	Fixed charge per da.	Cost of tile (yarded) per da.	Cost per M. ft.	Cost per ton
5	1,000	9	$21.00	10½	26.5	$ 44.00	15	$ 9.00	$14.00	$ 88.00	$22.00	$14.20
6	4,000	9	21.00	13	32.5	54.00	29½	17.70	23.00	148.00	41.00	3.60
8	3,600	9	21.00	23	52	86.30	18½	11.00	14.00	100.00	25.00	3.85
10	3,000	10	23.25	34	61	101.20	35	21.00	37.50	173.00	57.70	3.40
12	2,400	10	23.25	45	67.5	112.00	38½	23.10	33.00	191.35	79.80	3.55
14	1,800	10	23.25	57	64.5	107.10	37	22.20	27.50	180.05	100.00	3.50
15	1,500	10	23.25	70	65½	108.75	37½	22.50	33.00	187.50	125.00	3.60
16	1,200	10	23.25	85	64	106.25	37	22.20	37.50	189.20	157.70	3.90
18	900	10	23.25	112	63	104.65	36	21.60	37.50	187.00	207.80	4.10
20	800	10	23.25	125	61	101.30	36	21.60	37.50	183.65	229.60	3.70
22	600	10	23.25	190	70	116.20	41	24.60	37.50	201.55	336.00	3.60
24	520	10	23.25	215	70	116.20	41	24.60	37.50	201.55	388.00	3.60
26	430	10	23.25	240	64	106.25	37	22.20	37.50	189.20	440.00	3.70
28	360	10	23.25	270	61	101.30	36	21.60	37.50	183.65	510.00	3.80
30	330	10	23.25	300	61	101.30	37	21.20	37.50	189.15	573.20	3.80
32	300	11	25.50	350	64	101.30	37	21.20	37.50	191.40	638.00	3.80
34	270	12	27.75	410	70	116.20	41	24.60	37.50	206.05	763.00	3.70
36	252	12	27.75	470	74	122.85	43½	26.20	37.50	214.20	850.50	3.60
39	225	12	27.75	545	77	127.80	45	27.00	37.50	220.05	998.00	3.60
42	190	12	27.75	635	75	124.50	44	26.40	37.50	216.15	1,138.00	3.60
48	144	13	30.00	635	75	124.50	44	26.40	37.50	216.15	1,500.00	3.60

In computing the table of costs a deduction of 5% was made from the cured weight of the tile as given to obtain the weight of the dry cement and sand. A deduction of 8% would be more nearly right but it would not be conservative to use this figure. The table shows the fixed charge applied to the smaller sizes of tile at less than the daily fixed charge of the whole plant and this was done for the reason that the smaller sizes are usually made while larger sizes are being made, and, further, the competition of the clay product on the smaller sizes is keen, so that some such adjustment must be met. The wall thickness of the 5″ to 20″ was taken as 1/12th the inside diam., the 22″ and larger were figured as 1/10th. Sizes larger than 22″ often, if not usually, require reinforcement, which adds 80 cts. to $1.50 per ton to their cost of manufacture. To the labor cost 75 cts. was added to the $2.25 average wage to care for a foreman. The production given is based on averages of several contracts and, of course, would not be attainable for a few days' operation. Add to the above costs the expense of management, costs of bonds where such are required, a few per cent for rejections on the ditch, loading and transportation charges and the profits.

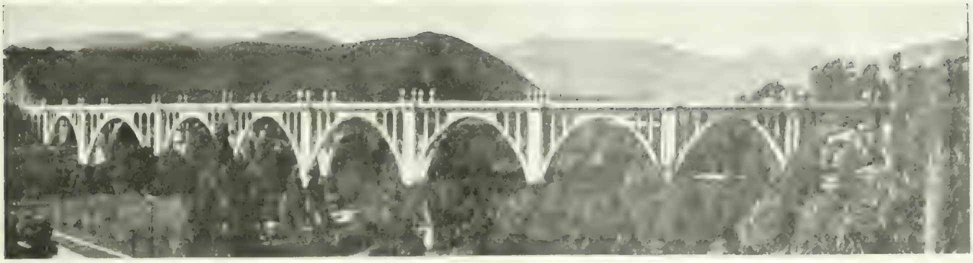

Fig. 1—General View Showing the 1,470-ft. Reinforced Concrete Arch Bridge Across the Arroyo Seco, Near Pasadena, Cal.

The white bridge stands out in bold relief against the green background

Arroyo Seco Reinforced Concrete Bridge Near Pasadena, Cal.

By Charles Alma Byers[1]

Since concrete has come to be so extensively used for this purpose, bridge building has developed into a real art. No longer is a bridge constructed to serve its utilitarian purpose alone; it is realized that it possesses certain possibilities for becoming a decoration to the landscape, and these possibilities are invariably made use of. The modern bridge builder must be not only a construction engineer but also an artist. And at the same time he must not sacrifice stability for art, for bridges must today be every bit as strong as they ever were, if not stronger.

An excellent specimen of the modern bridge builder's art is seen in the mammoth concrete bridge completed a short time ago near Pasadena, Cal. This bridge, shown in Figs. 1, 2 and 3, spans the beautiful Arroyo Seco, and is in close proximity to a number of fashionable residences. In fact, it provides the outlet for one of this wealthy little city's principal residence streets, and connects with a much traveled boulevard leading into the city of Los Angeles. Only a short distance from one end of it is also located one of southern California's most popular country clubs, and for these and other reasons this bridge is indeed much used by automobilists. The Arroyo Seco is extremely picturesque, and therefore there was every reason for designing the bridge that should span it so as to form an artistic embellishment to the natural beauty of the locality.

Some idea of this charming setting and how admirably this bridge is fitted into it may be gained from the accompanying ilustrations. The Arroyo Seco is at this point nearly 1,500′ wide, but only a comparatively small portion of this width is ordinarily occupied by the bed of the wet-weather stream which traverses it. The remainder is a wilderness of trees, here and there cleared to provide plots for bungalows and gardens. The bridge reaches across it in a slight curve downstream and its roadway is elevated about 160′ above the lowest point of the depression. It is constructed entirely of reinforced concrete, and the almost pure white structure, with its graceful lines, stands out in bold and charming relief against the green background (see Fig. 1).

The natural foundation of the piers is uncommonly good. The valley spanned, throughout most of the width, is of a conglomerate formation of boulders and gravel, affording excellent foundations at small depths below the surface. Adjacent to the bed of the stream the piers rest on solid rock.

DESIGN FEATURES

The bridge consists of a series of arches, and has a total length of 1,470′, of which about 800′ is on a curve, and the remainder on a tangent. There are six spans of 113′ each, two of 151′ 6″ and one of 223′ c. to c. of piers, besides six small girder spans in the form of arches, and abutments at each end. For reasons of economy it is slightly curved in its alignment, giving the shortest distance over the deepest part of the gorge and affording rather high ground for the piers.

The bridge provides a roadway 28′ wide between curbs, paved with asphalt, and two concrete sidewalks, each 5′ wide. Over each pier is a projecting bay, widening the sidewalks at these points to 8′, and containing a concrete bench. At each end of these several benches is an ornamental electrolier, each having five light globes, as shown in Fig. 3, and along the outer edge of each of the sidewalks runs an artistic concrete hand-rail. The roadway, and consequently the walks, has a grade of 2.65%.

In general design the arch spans of the bridge consists of two continous elastic arch ribs carrying

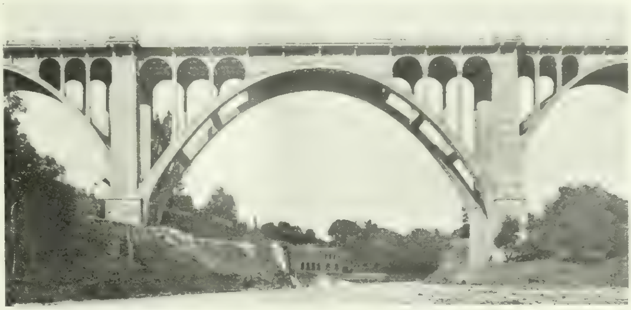

Fig. 2—Near View of the Single Span that Crosses the Stream

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[1] Los Angeles, Cal.

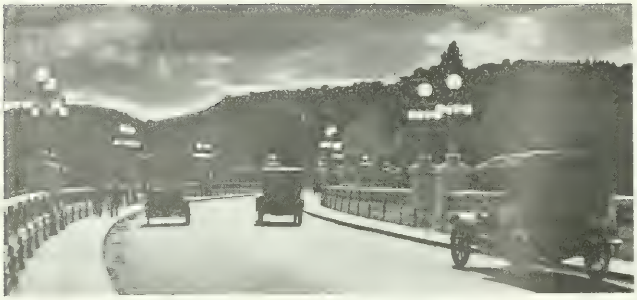

Fig. 3—View Showing Roadway of the Arroyo Seco Bridge

This view shows the bridge as seen in the dusk just as the lights begin to glow. The bridge is much traveled by automobilists

what are called spandrel colums and in part spandrel walls, on which rest cross-beams with cantilevered ends. The slabs of the roadway and of the sidewalks rest on these cross-beams and over the longer arches on longitudinal beams connecting the cross-beams. The pairs of arch ribs are connected by transverse tie-beams at about the location of each spandrel column. The arches are generally parabolic in outline, and each span is independently stable. The piers at each point are continued up to the roadway; this arrangement provides both lateral and longitudinal stability. The two halves of each pier are joined together by a massive arched slab below the springing line of the arches, but above the springing line the two sides are independent. The six smaller arches are exact duplicates in design and proportions, and were molded by the repeated usage of the same forms and falsework.

The hand-rails on each side of the bridge's passageways are designed with round concrete pilasters. These pilasters were all cast from one mold, but the top and the bottom rails and the posts were cast in place.

The structure contains a total of approximately 11,000 cu. yds. of concrete and about 600 tons of reinforcing bars. The greater part of the concrete is composed of 1 part Portland cement, 2 parts sand and 4 parts stone or gravel, the latter graded to pass through a 1-in. ring. The piers below the coping work at the springing line are of a 1:3:5 mixture, the maximum size of the stone or gravel being 2½″. Boulders are embedded in this portion where they will not interfere with the reinforcing. The shafts of the piers above the springing line are of a 1:3½:7 mixture with small aggregate.

The reinforcing is of corrugated bars rolled from open-hearth steel of an ultimate strength of from 60,000 lbs. to 70,000 lbs. and with a minimum elastic strength of 35,000 lbs.

LOADS

The structure is designed for a live load consisting of Class B of Waddell's "De Pontibus," with impact determined by the formula $I = \frac{100}{L+150}$, which consists of a load varying from 123 lbs. per sq. ft. for a loaded length of 100′ up to a maximum of 166 lbs. per sq. ft.

The following road-roller loads were considered: An ordinary 15-ton road-roller, with which permissible stresses of 500 lbs. per sq. in. of compression on the concrete and of 15,000 lbs. per sq. in. tension on the steel were assumed, and an emergency road-roller weighing 21 tons; for this loading the above intensities were increased to 650 lbs. and 20,000 lbs. per sq. in. respectively.

The wind loads figured were 30 lbs. per sq. ft. of exposed surface for the unloaded structure, and 15 lbs. per sq. ft. of exposed surface for the loaded structure.

UNIT STRESSES

Except as mentioned, the allowable unit stresses are: For concrete in compression, 600 lbs. per sq. in.; for concrete in tension, zero; for concrete in shear when combined with tension —(a) when without reinforcement, 35 lbs. per sq. in.; (b) when a portion of the tension reinforcement is bent, 50 lbs. per sq. in.; (c) where the web is reinforced to carry diagonal tension, 120 lbs. per sq. in. For steel in tension, 15,000 lbs. per sq. in.

When considering wind and temperature changes, the above stresses are increased 30%. These working stresses are increased 30%. These working stresses were used with certain other limitations in design. In the calculations every possible condition of partial loading of single spans and of adjacent spans was considered, and the extreme conditions provided for.

As before stated, most of the piers are founded on boulders and gravel, and a maximum intensity of 5½ tons per sq. ft. was allowed on the foundation.

MIXING CONCRETE

The methods of construction employed by the contractors were simple and particularly economical for an undertaking of this kind. This may be noted especially in the methods of mixing and placing the concrete.

The mixing plant consisted of elevated bins for the sand and the gravel, which were discharged by gravity, the contents passing into a chute where the aggregate was measured and the cement, brought in from an adjacent storage house, by gravity also, was added. A gasoline-driven concrete mixer, of 20 cu. ft. capacity, Ransome type[2], received the material and discharged it into steel dump cars.

TRANSPORTING CONCRETE

These cars were run on a track carried on a trestle supported on the framework or later on the partly finished roadway, following the center line of the structure. This track ascended until it was about 12′ above the finished roadway and then continued on the final uniform grade of 2.65% throughout the entire length of the bridge. The trains of cars carrying the concrete buckets were controlled by a cable, which hauled the cars up a short grade and over a hump, and then controlled them while they ran by gravity to their proper location. After dumping, they were drawn back by the engine—a single-drum, oil-burning hoisting engine—with sufficient speed to carry them over the summit and so down to the mixer again.

The concrete was dumped from the cars into a movable distribution hopper, from which it was dumped through a controlled opening into steel troughs and from which it, in turn, passed to its final position in the form. Only two men were required to handle the concrete mixer, one at the hoisting engine and one at the receiving hopper. From four men to six men usually placed and spaded the material in the forms, making a gang that rarely exceeded 10 men.

For a large part of the work only two coupled cars, each of ¾ cu. yd. capacity, were used, but when the work on the farther portions was in progress trains of three cars became necessary. A hopper was provided at the mixer to hold one load until the cars could be returned and while a second batch was being mixed. This enabled the cars to be filled immediately. The cars when traveling to the fifth pier, or a distance of about 500′, made the round trip in an average of 4 mins., and when going to the farther end about 8 mins. became the average. The force of 10 men, with this equipment, placed an average of about 120 cu. yds. of concrete each working day.

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[2] Ransome Concrete Mchy. Co., Dunellen, N. J.

FORM WORK

The construction of the forms and falsework, of course, necessitated the larger number of men, but here again economical management prevailed. The smaller arches are exactly alike in design, and this permitted the use of the same forms over and over again. The design for the larger arches is also practically the same, the arches differing in size only. Many of the special parts were prepared at the mill, and the timbers used throughout were planed, so as to give a smooth surface. For parts of certain cornices, for the capitals on spandrel columns, for the cantilever beams and for certain small projections from the general surfaces, however, specially prepared sheet metal forms were used, these being fastened to the wood forms at the proper places.

The falsework for the smaller arches consisted of 8-in. x 8-in. posts, with 2-in. x 6-in. bracing, and three posts per bent were used—one under the center of the roadway and one under each arch rib. The caps were 12-in. x 12-in. timbers, which extended all the way across. Only the central bents were made vertical, the others leaning toward the piers. The sheathing and the side forms for the ribs were supported on three joints under each rib, resting on the wedges at each cap. The forms for the tie-beams between the arch ribs were carried by small trusses of 2-in. x 6-in. pieces, spaced about 3′ 10″ o. c. and resting on the two adjacent caps. The falsework for the larger arches was designed very much the same, differing mainly in that 10-in. x 10-in. posts were used. The posts were supported on ground sills of suitable dimensions.

The timber for the forms and falsework was hoisted by a team of horses, and all other material requiring lifting was hoisted or moved by manual labor.

In the construction of the bridge from 40 men to 70 men were regularly employed. Most of these were carpenters, who were used for building the falsework and forms. The concrete workers were usually limited to eight or 10.

PERSONNEL

The bridge was designed and constructed under the supervision of Waddell & Harrington, cons. engrs., Kansas City, Mo., C. K. Allen being the local representative. The construction contractor was the Mercereau Bridge & Construction Co., Los Angeles, Cal. The total contract price, including everything necessary to equip it for service, was $188,000. It was built from funds supplied jointly by Los Angeles Co. and the City of Pasadena.

Action of Alkali on Concrete

The U. S. *Reclamation Record* presents a concise discussion of the action of alkali on concrete, based upon government investigations to date.[1]

What do we know about the disintegrating effet of alkali waters and soils on concrete? This question can, perhaps, be answered best after breaking it up into several narrower questions as follows:

(a) Does alkali disintegrate concrete?

(b) What forms of alkali have the greatest disintegrating effect and therefore require the greatest precautions against such disintegration to be taken?

(c) What kind of concrete is most easily disintegrated by alkali action?

(d) Can concrete be made that will withstand the most destructive kind of alkali?

(a) It has been found that concrete is disintegrated through seepage action of alkaline waters under certain conditions.

(b) Investigation has shown that the principal salts acting to produce disintegration are the sulphates, and especially magnesium and sodium sulphates. It is thought that of these the former is the more active, but this has not been definitely established. Different localities have shown different results for the same materials. Two extreme cases may be cited in the Sunnyside and the Belle Fourche project. Of a number of test specimens exposed on the former no disintegration was observed at the end of about 11 mos. with the exception of a specimen containing a soap and alum solution in the mix; the specimens were all of a 1:3:5 gravel mixture. Furthermore, none of the concrete structures on this project has been affected. On the other hand, various mixtures exposed on the Belle Fourche project were all found to be disintegrated at the end of 8 mos., with the exception of a 1:2 mortar specimen, which was not affected. Concrete structures on this project have also been disintegrated by alkali. Other projects showed intermediate results. Analyses of samples from the Belle Fourche project show magnesium and sodium sulphates present in strong solution, with the former predominating, and from the Sunnyside project show sodium sulphate only, and in much lighter solution. As a general proposition, it must for the present be concluded that in locations where alkali is present containing these salts, special precautions must be taken to prevent its possible action, unless experience with structures previously built has shown no deleterious effect, as in the case of the Sunnyside project above cited.

(c) It has been quite clearly demonstrated that the leaner mixtures of concrete are more easily disintegrated than the richer; also, that the more scientifically proportioned mixtures—that is, those having least voids for given proportions of cement and aggregate give better results. This is a natural result, as the action results from seepage of water into or through the concrete, which is retarded by the richer and more scientifically proportioned concrete.

(d). A direct and definite answer cannot be made to this question. Experiments have, however, shown that the more nearly impervious the concrete the less it is disintegrated by alkali. It is a natural deduction, therefore, that waterproof concrete will resist alkali action. Such concrete under certain conditions may be difficult to produce. Laboratory experiments have shown that it is possible to produce concrete that is practically impervious to water up to 50 lbs. to 75 lbs. pressure, and satisfactory results have been obtained in the production of an impervious concrete in the field on structures where special pains were taken toward that end.

There are numerous patented waterproofing compounds on the market; there are also being manufactured several so-called alkali-proof cements. A number of these have been tested, but the results have not been any better than those obtained with straight Portland cement. Sand cements also have so far shown no superior alkali-resisting qualities. J. Y. Jewett, cement expert, gives his tentative opinion "that with good cement, with care in the selection of suitable aggregates, with proportioning to produce a rich dense mixture, and with proper methods of mixing and placing, it is possible to produce a dense impervious concrete that will withstand the alkali action under ordinary conditions without the use of any special materials for waterproofing purposes." With fairly rich concrete an impervious skin of neat cement or rich mortar, such as is produced by working a flat spade between the concrete and steel or surfaced wood forms, will no doubt also have much effect in resisting the action of alkali.

When it comes to talk about the secret Navy laboratory and $5,000,000 workshop in which the government Naval Board is to work out its plans, concrete is the only building material thought of. The resolutions of the Board in reference to their new home provide "that the building shall be of modern concrete construction, with metal sills and doors, wire-glass windows and ample fire protection." Thus as time goes along every new and serious undertaking requires concrete for its development.

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[1] See also CONCRETE, Oct., 1915, issue, p. 145

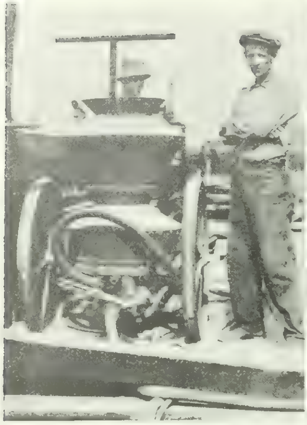


FIG. 1—GENERAL VIEW OF CEMENT GUN

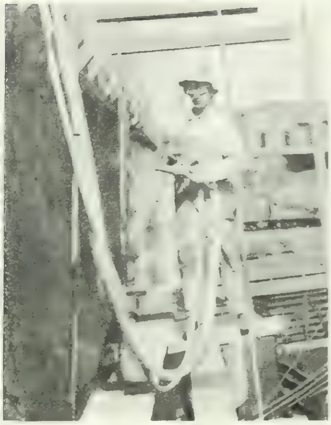


FIG. 2—SHOOTING GUNITE ON THE STEEL VIADUCT

Protecting Steel Viaducts With Concrete

BY WILL C. PARSONS[1]

A steel viaduct 560′ long, consisting of eight girder spans bridging 40 R. R. tracks at Columbus, Ohio, was so deteriorated from the effects of locomotive smoke as to make replacement necessary.

It was decided to increase the width of the structure 20′, making the roadway of the new bridge 50′ wide with a 7-ft. 6-in. sidewalk on either side.

As it was necessary to build new piers, and to erect the new bridge without interrupting city or interurban street car traffic over the old bridge, novel traffic methods were worked out.

Excavation for the piers was made by means of a derrick car on the old viaduct, which loaded the dirt onto cars on the steam R. R. tracks 26′ below.

The contractor constructed the concrete piers and placed the steel for the 20-ft. extension from the deck of the old bridge. A temporary track was then placed on the steel, and street car traffic diverted from the old bridge to the temporary track on the extension.

The old structure was then removed by cutting the steel away with the oxy-hydrogen flame.

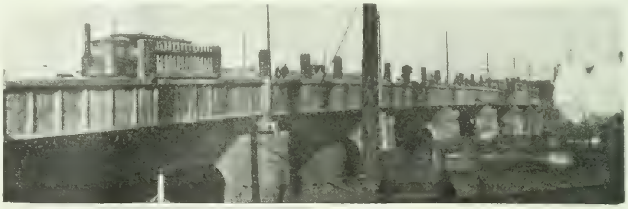
The feature of the work is the protection of the steel. Concrete protection in the form of gunite, was shot on with a cement gun[2] working at 40 lbs. pressure. The apparatus used provides for shooting the proper quantities of cement and sand through one hose, whereas water is supplied through a second hose and the mixture is made at the nozzle. The wet mixture is delivered against the steel in the form of a spray under 40 lbs. pressure. Two inches of concrete was applied to the web and 3″ to the flanges and bracing members, where wire mesh was attached to the steel by wiring through holes drilled for the purpose.

No special treatment of the gunite was used except on the spandrel girders, where particular care was taken to have a reasonably smooth surface as the rest of the work was unexposed except below, no particular care was taken except to have the coating of reasonably uniform thickness. The equipment used consisted of a cement gun and a 50-h. p. Sullivan 9-in. x 12-in. x 12-in. straight line air compressor large enough to develop 260 cu. ft. of air per min. at 40 lbs. The operating crew consisted of a foreman, an engineer, a man to operate the valve on the cement gun and two men at the nozzle. Two men were employed to feed material to the gun and four to prepare the mixture as delivered. Water pressure was maintained at 40 lbs. by an auxiliary pump.

The deck of the bridge is of reinforced concrete, paved with brick. Parapet walls were cast in wood forms and reinforced with ½-in. round steel rods doweled to the stone coping of the approaches and anchored to the steel girders. Expanded metal was wired to these rods further to reinforce the parapet. As this part of the work was done in cold weather it was necessary to protect the work with straw and to use salamanders and a steam line for additional warmth.

Expansion and contraction were cared for by roller bearings placed on all piers except the center pier, leaving the viaduct free to expand each way from the center. A 3-in. maximum expansion at each end is provided.

Engineering features were handled by R. H. Simpson, assistant City Engr. of Columbus, and the contract was carried out by D. W. McGrath & Sons,[3] Columbus, at a cost of about $450,000.



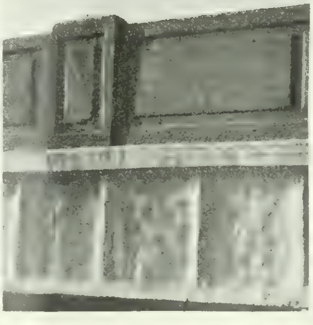


FIG. 4—GENERAL VIEW OF 4TH STREET VIADUCT, COLUMBUS, OHIO

FIG. 5—DETAIL OF GUNITE COVERED STEEL AND CONCRETE PARAPET

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[1] Worthington, Ohio

[2] Cement Gun Co., N. Y. C.

[3] Columbus, Ohio

Methods Employed in Wrecking Reinforced Concrete Buildings[1]

On account of the great progress in the construction of concrete buildings the early buildings have in some cases reached their limit of usefulness and have been wrecked to make way for more modern structures.

In a technical and practical treatise on the methods of breaking up structures of concrete and reinforced concrete, which has recently appeared the author includes a number of highly interesting and timely problems concerning which little has ever been written in any language. The author comments on the fact that the most instructive examples cited in his work are accounts of the wrecking of buildings in America.

BREAKING UP MASS CONCRETE

The author describes the methods used in breaking up pavements in various German cities with the use of compressed air drills and then gives considerable space to the use of explosives for wrecking.

Use of Explosives—For the destruction of heavy bridge piers, retaining walls and foundations of mass concrete, explosives have repeatedly been used, both heavy charges which with one shot destroy the object, and the slow, but in many ways more convenient, light charges.

The heavy charge will on account of the force exerted destroy the entire surrounding masonry; however, this method separates the structure for the most part into large blocks which must be broken up still more by the use of small explosive charges. (It is interesting to note that at this point the author inserts a footnote reading as follows: "The German concrete bridges in the vicinity of the French frontier are provided with mine chambers in the abutments and the middle piers, access to which is gained through locked manholes. This should in case of war allow a very quick destruction by means of a mighty explosion.) The light explosions are materially aided in their work since the first explosion opens up the joints in the concrete. Internal cracks also aid in weakening the cohesion so that the block is easily broken up.

If small charges of explosives are used entirely, holes are drilled in the same manner as for blasting stone, and fired when the men are not working. In general it can be said that the breaking up of rich gravel concrete will require deeper holes and heavier charges than lean concrete in which crushed limestone was used; for the latter black powder is generally strong enough. Exact rules cannot be given, each case requiring individual treatment.

Unless such work is undertaken by specialists who have laborers trained in the use of explosives and the use of special tools, the cost of breaking up mass concrete will be greatly increased even if the engineer in charge is of the highest ability. The author therefore advises that in all cases such work be let to specialists familiar with the wrecking of concrete structures.

The chemical destruction of concrete, which has more than once been agitated, can be characterized as Utopian to the fullest extent. We know of no practical, available solvent for the strong silicic acid substances released by the cement. Even if such a solvent were available the density of the concrete would prevent the desired action from taking place.

Reviewing the examples cited and the results of practice, the principles of the destruction of mass concrete can be set forth in a clear manner as follows:

1. For large masses of concrete the same methods as are used for quarrying can be followed. 2. Skilled labor selected on the basis of tests and experiments, tools and explosives should be used for this work. 3. For further breaking up pieces of concrete, stone chisels (for hand work) or compressed air chisels can be used. 4. The economy of compressed air chisels varies proportionately as the wages; cost is therefore, on account of recent increases in wages, rapidly increasing. 5. For small masses of concrete the use of explosives is out of question and only points 3 and 4 need be considered.

WRECKING REINFORCED CONCRETE STRUCTURES

Descriptive examples of methods of wrecking reinforced concrete buildings are given in the third part of the book. Experiences with this subject are extraordinarily few and it is only possible to lay down rules for the actual wrecking of concrete buildings by basing them on the practical applications cited.

Short descriptions of methods of wrecking used on buildings in Baltimore, Chicago, Mannheim, Germany and other localities, including a coal washer in Stockholm, Sweden, are the foundation for the rules later laid down by the author.

Breaking up thin slabs of beam and slab floors is easily accomplished. On account of their hardness they cannot be readily worked on with hand chisels or even with compressed air chisels or drills, but on account of their brittleness they can readily be broken up into small pieces by letting heavy weights fall for a short distance upon them. Whether this is to be accomplished by a freely-falling, heavy ram, as was used in wrecking the building of the Baltimore News Pub. Co., or by the use of hand sledges, as in the wrecking of a coal-washer at Stockholm, is mainly a matter of judgment of the structural engineer. In general a sledge-hammer will suffice for thin slabs, but for thick slabs a heavy ram handled by several men will be found more satisfactory and economical. The span between supporting beams is an important factor inasmuch as for long spans the desired results can be obtained by comparatively light blows.

It is of considerable advantage to allow the supporting beams to remain in place and act as supports for a light wooden platform to carry the laborers. In most cases, however, such precautions are unnecessary since the steel reinforcement of the slabs, separated from the concrete, remains uninjured and anchored into the beams, while the broken concrete of the slab which has not fallen in the form of small particles of dust can be readily removed by hand.

This method of breaking up slabs is limited to those of a thickness up to 6″ to 6½″ while for very long spans this limit is perhaps somewhat higher. For greater spans this method of breaking up, by means of blows applied to the top of slab, seems to be uneconomical; for with heavy weights or concentration of the work at one point it is always possible that a sudden breaking of a slab and the adjoining beam will carry the workmen down with it. Special protection in the story below for such emergencies is in general too costly. For this reason it is necessary to treat thick slabs in the same manner as beams.

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[1] Abstracted translation by Albert M. Wolf from *Der Abbruch von Beton und Eisenbetonbauten*, by Ernst Schick; published by Wilhelm Ernst & Sohn, Berlin

Beams should be cut off near the support. The location of the cuts can be from 12″ to 16″ from the support so that the workmen will not be endangered by the fall of the middle portion. The haunches of the beam should not be cut, but rather the least cross-section of the beam, which involves a minimum amount of labor. The ends of the beams remaining on the columns can be removed when the columns are torn down. Cutting the beams can be accomplished by splitting the concrete with a hand chisel or an air hammer. This latter tool is especially well adapted since by the use of long, thin chisels of steel very narrow cuts, 1″ wide, can be made for the entire depth of the beam, and also because the amount of work is greatly diminished as compared with that required with the use of hand chisels. The reinforcing bars can also be cut by blow-flames, which are essentially more rapid and economical than steel saws. The use of steel saws, however, is not to be overlooked in small work where the installation of a blast flame is too costly and in cases in which such a large and heavy apparatus is inaccessible. There are today quite a number of cutting flames which do good work; among them the much used Autogen gas flame; different hydrocarbons in connection with clear oxygen and lastly, the oxy-hydrogen flame. The oxy-acetylene flame, used a great deal in wrecking concrete buildings, is a good example of such a device. The following description is that of the wrecking of the Gillender Bldg., in New York.[2]

> The apparatus for producing the flame consisted of three steel acetylene cylinders about 2′ long and 1′ in diam. Each cylinder contained 6 cu. meters of acetylene under 11 atmospheres pressure. The cylinders were filled about ⅔ full of Aceton, a porous preparation, which, under normal pressure, absorbs 25 times its volume of acetylene. The oxygen was kept in a cylinder under 25 atmospheres pressure. The apparatus for producing the flame was of brass. The forced flame burning under a pressure of 10 atmospheres burned a mixture of 1.28 parts of oxygen and 1 part acetylene. When the flame had heated the metal to a red heat a stream of pure oxygen was directed on the heated portion, which brought about a rapid oxidation.
>
> Cutting heavy sections of iron and steel, and even cutting columns filled with concrete, is readily accomplished by this method.

Difficulties are encountered, however, in cutting members composed of several plates riveted together. Riveted members are very seldom used in reinforced concrete construction and this is perhaps the reason for the extensive use of blow-flames for wrecking concrete buildings, the cost of which is greatly exaggerated by those interested in steel construction.

Compressed air drills have reached a high state of development and are being used in greater numbers both in Germany and in other countries. Electric vibratory drills have proven less satisfactory for this class of heavy work; they are better adapted to slow drilling in a homogenous material. They may, however, be justly given consideration where electric current is cheap.

The middle portion of the beam after being cut from the supports will fall to the floor below. With this method of wrecking a greater advantage is gained in that the vertical fall and the violent shaking of the piece of beam bring about a breaking up of the concrete and a loosening of the steel bars, and what is more, it breaks up the lower floor and thereby aids considerably in its destruction.

After all the beams and slabs have been broken up the columns with the stub ends of the beams still in place can be overturned. This can be done by cutting away one side at the foot of the columns, as is done in the wrecking of high chimneys, the direction of the fall being very readily governed in this manner. Here also the shattering effect of the fall is as effectual on the floor which breaks the fall as on the column itself. Special care and preparation are unnecessary, since the mass of a column 10′ to 13′ long is not very significant; for this reason two complete floors can be wrecked and the columns then wrecked in two-story sections. In the lower stories where the columns are large and heavy, blasting can be resorted to in place of cutting. In this case the columns are attacked from one side only to regulate the fall, by drilling deep holes and loading them with a light charge of explosive.

Reinforced concrete walls should be first cut into sections from 6′ to 9′ wide and then cut off at the bottom and overturned with the aid of a rope or a heavy timber used as a ram. The shattering effect of the fall loosens the steel and breaks up the concrete. This done, the wrecking of a complete story, composed of slabs, beams, columns and walls, is finished. For wrecking buildings in closely built up sections of a city, where street traffic and neighboring buildings must be safeguarded, a carefully laid out plan must be carried out. With isolated industrial buildings the structural engineer has an excellent opportunity to use the method of wrecking which best suits the conditions.

Destruction by free fall is most often suitable for application as just described in the destruction of a story; where practicable try wrecking two or more stories at once by overturning complete parts of a building outward, inward, against or upon one another; and finally, in very heavy construction it is possible to destroy the entire structure at once by the sudden breaking up of the basement supports with explosives. This method of destruction for buildings is very seldom feasible, but it can be used for wrecking bridges.

In general the order of wrecking should be from top to bottom. The experience gained in the destruction of a concrete building in the Chicago stock yards, however, shows that under certain conditions the reverse order of procedure is more desirable.

CONCLUSIONS

By drawing conclusions from the foregoing, the following program of sequence governing the wrecking of buildings is obtained:

1. Removal of the windows, doors, wood floors, brick spandrels, parapet walls, roofing and miscellaneous installations.
2. Destruction of floor slabs.
3. Cutting off the beams between the hanches and dropping them to the floor below.
4. Pulling down columns, by cutting them off at the base.
5. Pulling down walls by cutting them up into sections.
6. Other arrangements for the wrecking of structures best to suit the conditions at hand, always considering the tools at one's disposal such as sledge hammers, compressed air chisels, breaking up parts by dropping them from their position and by comparatively light but well placed charges of explosives.

COSTS

Rules as to the cost of wrecking are not easily laid down. Based on the data regarding the wrecking of a coal washer in Stockholm an average cost of $1.85 per cu. yd. is obtained. Assuming the cost of construction as $18.35 per cu. yd., the cost of wrecking amounts to 10% of the cost of construction. These costs are considerably reduced by the salvage. For ordinary dwelling and factory buildings considerably lower costs of wrecking can be assumed, about 92 cts. per cu. yd. Since the value of the steel removed remains the same, a wrecking cost of 92 cts. per cu. yd. amounts to 5% of the construction cost of $18.35 per cu. yd. This is the same value as is given by builders for ordinary brick buildings. Handbooks on building work give the wrecking cost of brick buildings, with all salvage deducted, at about 5% of the cost to erect.

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[2] Volume 62, *Engineering News*

By proper arrangement and planning the cost of wrecking reinforced concrete buildings (at least in Germany) is not greater than that for brick and steel construction. The conclusion is also drawn that the technical problems arising are not so difficult that they cannot be readily solved by the engineer of any modern construction company.

Grading Aggregates for Illinois Concrete Roads

The accompanying table from a paper by A. H. Hunter, a division engineer of the Ill. Highway Comm., before the Ill. Soc. of Engineers and Surveyors, gives the present requirements as to gradation of aggregates for concrete road work in Illinois.

Table 1—Limits of Gradation of Aggregate

Coarse Aggregate

Size of Screen	Allowable Limits of Percentage Passing Through
1½-in. round mesh	100
¾-in. round mesh	Not less than 40 nor more than 70
¼-in. round mesh	Not to exceed 5

Fine Aggregate

Size of Screen	Allowable Limits of Percentage Passing Through
1/4-in. square mesh	95 to 100
1/16-in. square mesh	Not less than 30 nor more than 75
1/50-in. sq. mesh	Not more than 15
1/100-in. square mesh	Not more than 5

From the same paper is the accompanying cost tabulation. Cost figures on the first four roads were published in this magazine[1] but are shown again here for purposes of comparison.

Beauty and Utility

Another thought as to the close allegiance of beauty and utility is gleaned from *Knickerbocker Komments:*

One reason why there are so many unsightly houses built by carpenters is the misconception on the part of the public that the mission of the architect is principally to add "embellishments" to a building with a commensurate addition to the cost.

The public thinks that art, which is simply another name for beauty, is something apart from everyday life.

Even a genius like Goethe wrote that the beautiful cannot be made to serve any practical purpose without injury to the artistic effect.

This seems still to be the prevailing popular idea, despite the thundering of Ruskin, Morris and other aesthetic leaders, who preached that in art "form follows function."

For example, no chair can be artistic unless it is useful as a seat. This statement is not so superfluous as it might appear at first glance. Some chairs are really not furniture—they are bric-a-brac. If you doubt it, look around in private parlors or in the "ladies' parlor" of fashionable hotels.

If an art museum, instead of being called by that name, were featured as an "Exposition of the Beautiful"—in paintings, tapestry, china, furniture, etc.—it would be a much more popular institution.

Table 2—Unit Cost of Several Concrete Roads Built By Day Labor Under the Supervision of the Illinois Highway Commission

	1912				1913				1914	
	McLean	DeKalb	Springfield	Carlinville	Jacksonville	La Salle	Springfield	Highland	Aurora	
Amt. pvt. laid, sq. yds.	5,000	7,334	5,594	7,111	2,148	10,663	8,566	6,680	2,942	Total sq. yds., 56,038.
Thickness of pvt., ins	6	6½	7	6½	6	6½	6-7	6	7	Av. thickness, 6½".
Width of pvt., ft.	45	12	18	18	18	20	9-18	9	18	
Length of haul, mi.	⅛	½	⅛	*1½-†½	1[illegible]	¾	⅞	4	¾	Av. haul., .91 mi.
Cost of cem., per bbl.	$1.02-$1.06	$0.55	$1.02½	$0.98	$1.285	$1.06	$1.02½	$1.40	$1.12	Av. cost cem., $1.05 bbl.
Cem. per sq. yd. pvt., bbl.	$0.29	$0.31	$0.29	$0.33	$0.28	$0.29	$0.30	$0.29	$0.36	30 bbls. cem. sq. yd. pvt.
Price labor, M. & T., cts.	20-40	22½-45	25-45	20-40	22¼-44½	35-62½	25.50	20.40	35-62½	
*Sand †Stone										
Cost of Labor and Supplies										
Superintendence	$ 140.00	$ 200.00	$ 202.00	$ 157.50	$ 87.00	$ 240.00	$ 405.00	$ 202.00	$ 225.00	
Exc., shaping road bed, trimming shoulders	307.41	1,042.37	443.82	700.43	231.94	1,682.60	2,490.07	1,427.50	354.80	
Loading and hauling sand and stone	267.34	596.02	603.50	795.05	229.94	1,798.98	1,482.46	1,480.00	325.70	
Mixing and placing concrete	414.63	746.65	644.25	700.58	231.37	1,415.07	1,245.07	656.35	442.00	
Covering and seasoning	......	......	......	......	.....	260.00	......	45.88	80.00	
Watchman and misc.	155.44	374.48	383.75	131.46	112.46	978.50	567.28	234.45	50.00	
Cost of sand and stone, f. o. b.	1,017.63	1,671.00	1,622.01	741.00	573.17	3,352.45	2,582.05	2,182.32	1,154.40	
Cost of cement, f. o. b.	1,547.15	1,250.00	1,551.17	2,307.90	833.08	3,301.00	3,055.71	2,794.32	1,193.92	
Expansion joints	48.67	160.13	206.74	112.40	28.00	299.00	253.28	248.32	109.58	
Reinforcing steel	......	......	......	100.00	5.00	......	......	......	......	
Coal and oil for mixer	30.75	32.00	119.19	25.00	21.10	224.49	98.47	99.54	15.00	
Forms and other lumber	35.00	119.77	18.33	31.75	16.61	79.74	61.80	40.35	40.00	
Total	$3,964.02	$6,194.42	$5,794.76	$5,803.07	$2,369.67	$13,632.16	$12,241.46	$9,413.03	$3,990.50	Total cost.....$63,403.09
Unit Cost Per Sq. Yd.										
Superintendence	$0.028	$0.027	$0.036	$0.022	$0.040	$0.022	$0.047	$0.030	$0.076	Av. cost sq. yd...$0.036
Excavation, etc.	.061	.142	.079	.099	.108	.158	.291	.214	.121	Av. cost sq. yd... .142
Loading and hauling sand, stone and conc.	.053	.081	.108	.112	.107	.169	.173	.222	.111	Av. cost sq. yd... .126
Mixing and placing concrete	.083	.102	.115	.099	.108	.133	.145	.098	.150	Av. cost sq. yd... .115
Covering and seasoning	....	....	....	....	....	.024	....	.007	.027	Av. cost sq. yd... .004
Watchman, etc.	.032	.026	.068	.018	.052	.092	.066	.035	.017	Av. cost sq. yd... .045
Cost of sand and stone, f. o. b.	.204	.228	.290	.105	.269	.314	.301	.326	.392	Av. cost sq. yd... .279
Cost of cement, f. o. b.	.309	.170	.277	.325	.388	[illegible]	.357	.418	.406	Av. cost sq. yd... .329
Expansion joints	.010	.022	.037	.016	.013	.028	.030	.037	.037	Av. cost sq. yd... .025
Reinforcing steel	....	....	....	.014	.022	.	....	....	....	Av. cost sq. yd... .002
Coal and oil for mixer	.006	.005	.022	.003	.009	.021	.012	.015	.005	Av. cost sq. yd... .011
Forms and other lumber	.007	.016	.003	.005	.008	.008	.007	.006	.014	Av. cost sq. yd... .008
Total	$0.793	$0.819	$1.035	$0.818	$1.104	$1.280	$1.429	$1.408	$1.356	Av. cost sq. yd...$1.113

The costs make no allowance for depreciation, overhead or profit.

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[1] CONCRETE, May, 1913, p. 223

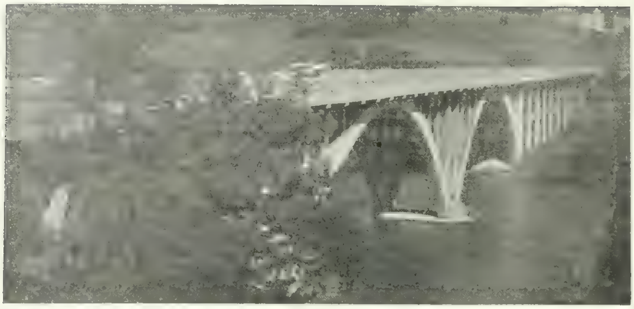

FIG. 1—CONCRETE BRIDGE AT ASHEVILLE, N. C.

Repairing a Concrete Bridge at Asheville, N. C.

BY CHAS. H. NEAL[1]

The Commissioners of Buncombe Co., N. C., have recently been confronted by a rather serious proposition because of the threatened failure of a large concrete bridge across French Broad river at Asheville, but they discovered the defects in time to make repairs before a failure occurred. The writer made plans and specifications for the repairs and directed the work, which afforded an opportunity to make very interesting notes of the original construction.

The object of this article is not to reflect on concrete as a structural material but to call attention to some weaknesses due to the work of our old friend, "Hap Hazzard," who was evidently on the job, and to place the responsibility for failure where it belongs.

The bridge consists of two arches spanning the stream proper, with approaches at each end made up of columns, beams and girders. Its entire length is 931′ and its width 35′, including a roadway, a street car track and a 5-ft. sidewalk. The approaches are supported by columns carrying two main girders, one on either side. Beams transversely between the girders support the floor.

The principal failures were in the girders at the abutment ends and consisted of the breaking off the haunches or braces which were poured simultaneously with the girders, presumably to lessen the span between the columns. Fig. 2 gives a detail of the construction at the abutment and also shows one of the haunches broken off and lying on the ground. The abutments were evidently constructed first, having slots left in them to receive the girders. At this point an attempt was made to provide for expansion and contraction but the effort seems not to have been very successful. The girders fit so closely in the slots as to allow no free movement of the parts. After excavation for repairs it was found that the abutment shown at Fig. 2 was cracked from the bottom of slot clear down through the footing to the earth foundation. This crack was apparently due to a poor foundation and the absence of reinforcement in the abutment and the footing. The failure of the abutment at this point allowed the girder to drop about 1¼″, causing dangerous looking cracks at the top, as shown. The same condition prevailed more or less at both abutments.

REPAIR METHODS

The method followed in making repairs and to guard against further failure was to go down to solid foundation, put in sufficient footings and build suitable columns to the girders. These columns were placed directly against the abutments and extended out far enough to cover the injured parts of the girders. After the concrete was set steel plates and wedges were driven between the tops of the columns and the bottoms of the girders to transfer as much dead load as possible to the new columns. The repair work was done in a manner so substantial as to make further trouble at these points practically impossible. Just what may develop at other points is doubtful because the design and construction do not seem to measure up to what one might expect in so important a structure.

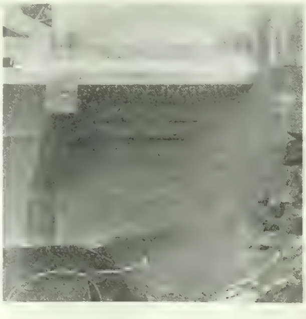

FIG. 2—DETAIL OF CONNECTION OF GIRDER AND ABUTMENT

One can but wonder why a little more attention could not have been given to detail, both in design and construction. The design seems to have been a combination of one made by the people representing a patented system and one made by the contractor who constructed the bridge. Under the circumstances it appears difficult to ascertain who was to blame for what went wrong. The weak features consist mainly in the placing of the reinforcement. The haunches or braces broken off show that no provision whatever was made for tying them on to the girders of which they were supposed to be a part. Inspection shows that reinforcing bars in girders, beams and slabs were allowed to lie for most part on the forms instead of being held up a proper distance from the bottom. As a result of this the thin scale between the steel and the outside has dropped off, leaving it exposed to corrosive influences, and decreasing the bonding surface of the steel and of the concrete.

By referring to the illustrations it will be seen that the sidewalk on one side and about 5′ of the roadway on the other are supported by brackets of the cantilever type placed at right angles to the main girders. The writer has been told that these brackets contain no reinforcement whatever and the statement is confirmed by the fact that some brackets have actually fallen off entirely, showing that they were not poured simultaneously with either the girder or the floor slab. How they hang there at all is a mystery, for an examination showed perfectly smooth joints between bracket and slab and between the end of the bracket and the side of the girder. Think of a 15-ton roller passing over a 5-in. floor slab supported in such a manner!

This structure, instead of furnishing an occasion for "knocking" concrete is really a triumph for concrete as a safe building material.

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[1] Highway Engr., Asheville, N. C.

Some Odd Jobs of Concrete About a Country Place

By William Main

A concrete plant bench for a conservatory or greenhouse, a concrete table top, a porch rail, a repair job on a porch floor — these odd jobs were done by Mr. Main for himself. Yet they are full of suggestions for the small contractor as most people are not just like Mr. Main and they want work of this kind done for them.

GREENHOUSE OR CONSERVATORY BENCH

It is well known that the ordinary wooden greenhouse bench lasts but a short time. Constant moisture and warmth provide ideal conditions for decay and five years or six years is the usual life of such a structure, which must then be rebuilt at the cost of considerable labor and interruption of useful work.

Fig. 4 shows a cross-section of a bench made of concrete, reinforced. The cost of material and labor is but little greater than for building a wooden bench, while its durability is infinitely greater. The expense is much less than for slate or tile construction, as sometimes adopted.

The sketch represents a bench with a concrete bottom, molded with numerous holes so as to provide both drainage and ventilation. These are essential, as every greenhouse man knows. The front of the bench is of concrete and the sketch also represents both the outer wall and the floor of the building, as of the same material. The dimensions are those adopted for a bench in a conservatory adjoining a private residence.

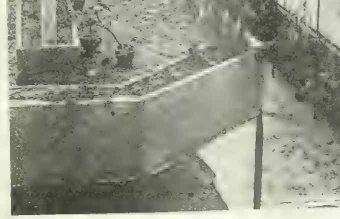
The uprights sustaining the front of the bench are of channel iron, the smaller sizes of this material being called "grooves." The uprights in this case are 1½" by ½" and ⅛" thick.

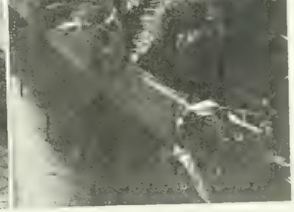
These are bolted to longitudinally placed angle iron, 1½" by 1½" by ¼". A bar of T iron is bolted as shown across the upper ends of the vertical supports, the "table" of the T thus forming a permanent protection for the upper edge of the concrete front, while a single small bolt passes through the groove iron and the stem of the T. The concrete is filled in flush with the front of the uprights and to whatever thickness may be considered desirable to form the front wall of the bench. The T-iron for the top edge is 1¼" by 1¼" by 3/16", the two former dimensions being those of the "table" and the "stem," as the bar appears in cross-section. The bottom of the bench is reinforced with T-iron of the same dimensions. These cross-ribs, which are spaced 18" apart, rest on an angle iron at the back wall which is 1½" by 1½" by ¼"; this, in turn, rests on short pieces of flat iron molded horizontally into the concrete back wall. These cross-ribs should be bolted to the horizontally extended angles at the front and the back, thus holding the whole structure together.

The bolts are the ordinary short stove bolts, being round-headed machine screws, provided with nuts and just long enough to go through the two thicknesses of iron. The upright supports in front, if spaced 3′ 6″ apart, will be amply strong enough for a bench of any reasonable dimensions.

The concrete forming the bottom and the front wall of the bench is reinforced with a strong iron network extending over the cross ribs of T iron and made to sag down between them so as to come within ½" or ⅜" of the bottom surface.

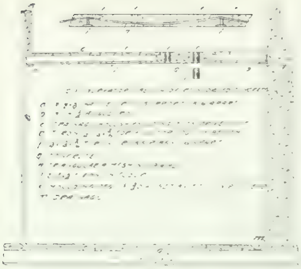
For a wire reinforcement I have used a network of No. 9 wire, in 4" triangular mesh, this material being especially made for reinforcing con-





Figs. 1 and 2—Exterior and Interior (Right—Bottom) Views of Conservatory, Showing Concrete Bench and Enclosing Wall

Fig. 3 -Benches of Concrete in Small Greenhouse



FIGS. 4 AND 5—DETAILS OF CONSERVATORY BENCH

crete. Lighter material, such as is used for chicken wire or tennis courts, is too flimsy.

In order to provide for drainage and ventilation the bottom of the bench must have numerous holes. These, however, are easily provided. Get a supply of dowel rods, such as carpenters purchase, to be cut up in short pieces as required for cabinet and similar work. These are round and straight, and usually of white birch. The ¾-in. size is about right. Cut these rods up into short pieces or pegs, as long as the bench bottom is to be thick. Drive into the end of each peg a small wire nail and cut the head of the nail off (with a wire cutter) so as to allow the remainder of the nail to project ½″. These pegs can then be set as desired over the boards which are supported up against the bottom iron cross-ribs of the bench, a blow of a hammer serving to set each peg wherever may be desired. Concrete is then filled in, being supported by the bottom form boards and smoothed over flush with the tops of the round wooden dowel pegs, which have been studded as thickly as it may be desired that the drainage holes should be placed. After the concrete has set and the form boards removed these pegs may be driven down and out with a hammer and the bottom of the bench will be found to be as solid as a rock, much stronger and more secure than any slate or tile bottom.

The front wall of the bench is reinforced in a similar manner by means of the wire netting (which is turned up for that purpose). It presents a neat appearance, being flush with the front edges of the flanges forming the sides of the upright grooves or channel iron supports, while the heads of the small bolts come between the side flanges, so as not to project. All the exposed iron framework should be painted with some one of the kinds of paint used to preserve iron.

Fig. 4 of the sketch shows a cross-section of the entire bench, while Fig. 5 shows a longitudinal section of a portion of the bottom between the cross-ribs of T iron, also showing how the wire is stretched over the cross-ribs and allowed to sag down between them.

In making a bench of this kind the only tools required are a hack-saw with a 10-in. blade, and a bench drill which serves to drill the bolt holes. Any handy man can do the entire job with the assistance of a common laborer.

The sketch shows the construction of both bench and floor in a conservatory; the floor is of reinforced concrete and the cross-joists of T-iron 2″ by 2′ by ¼″. The same kind of wire network is used between them that has been described in connection with the bench. The floor is made with a slight inclination towards the drainage gutter next to the wall under the bench. Thus the floor may be conveniently washed with a hose in a few minutes. As an adjunct to a private residence a conservatory built in this way has proved a source of great domestic comfort, forming also a cheerful sitting and lunch room, even in winter.

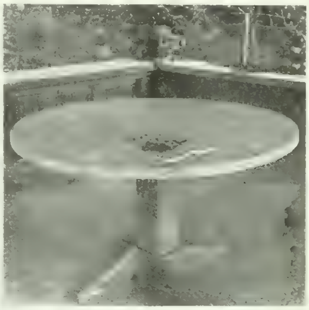


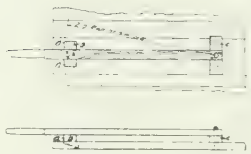
FIG. 6—TABLE WITH CONCRETE TOP

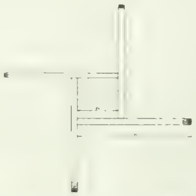
The bench illustrated in Figs. 4 and 5 is 31″ high, 33″ wide, 5½″ deep inside, with front wall and bottom 1½″ thick. These dimensions may be varied greatly, using the same reinforcing metal, which is amply strong enough for larger benches.

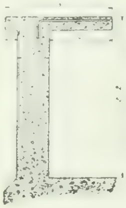
A TABLE WITH ROUND CONCRETE TOP

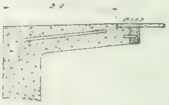
Figs. 7 and 8 show in section and plan the tool and part of the mold boards used in preparing the table top. A platform is made somewhat larger than the diameter of the table and a strip of metal is set on edge thereon, in a perfect circle, so as to form the circumference of the mold. This strip projects above the mold boards just high enough so that when filled full of concrete, which is smoothed over flush, the table top will be of proper thickness. Reinforcing metal is suitably placed before filling the space within which the disk-like slab of concrete is to be molded.

If the strip of metal is 2″ wide it should be set ½″ into the support boards so as to form a wall or boundary 1½″ high. A circular saw-cut









FIGS. 7 AND 8—SKETCHES SHOWING HOW TO LAY OUT CIRCULAR TABLE TOP

FIG. 9—SUGGESTION FOR WOOD PEDESTAL

FIG. 10—DETAIL OF PORCH RAIL TOP

FIG. 11—DETAIL OF REPAIR JOB FOR PORCH FLOOR

FIG. 12—PORCH FLOOR REPAIRED

of exactly the proper depth may be made as illustrated in Figs. 7 and 8.

A piece of a butcher's saw blade of, say, 1″ in length, is secured to a block of wood, the side of which is shaped so as to correspond exactly with a small arc of a circle of the diameter of the proposed round table. The saw blade should project just ½″ below the block as shown at *d*, Fig. 7, the saw blade being marked *a* and the block lettered *b*. The block, with saw blade attached, is then secured to a wooden handle which swings around a pivot peg. The cross block *c*, serves to keep the radial swinging bar parallel with the molding platform, and also, by extending a few inches crosswise, serves to steady the tool. Holding one hand over the pivot and operating the handle with the other, the tool is then swung back and forth pressing the saw blade lightly downward so that in a few minutes a perfectly circular saw-cut is made, exactly ½″ deep and of the required radius.

The strip of metal is then pushed down into this saw-cut, and after placing whatever iron lathing, wire or other material may be considered necessary for reinforcement, the concrete may be poured in and smoothed over flush with the top edge of the metal. A ribbon or hoop of thin steel is very suitable for the purpose required. Figs. 7 and 8 show a tool constructed for a radius of 2′, making a round table 4′ in diam.

A simple plan for making a pedestal is shown in Fig. 9. A piece of board, appropriately shaped, is screwed to each of the flat sides of a square upright of suitable height. Similar boards, secured to both the upper and the lower end of the upright, furnish both the radially extending feet and the supporting arms. (A concrete pedestal to support the table top would undoubtedly be more stable, certainly more durable.—Editor.)

A table top of this kind is naturally quite heavy so that it is not likely to be pushed out of place but dowel pins of wood (or preferably metal), projecting upward from a wooden support of this kind and fitted into corresponding recesses on the under side of the table, prevent any possible shifting when the table is in use. A table of this kind is especially adapted for a summerhouse, or for outdoor use generally. It has a neat and substantial appearance.

CONCRETE RAIL

Fig. 10 shows the construction and dimensions of a concrete rail which has been found a very comfortable adjunct to either a summerhouse or a porch. It really seems partly to furnish a place of this kind, giving it an air of comfort and convenience. The broad low rail top affords a continuous table for books, newspapers or ladies' work, and is not too high to sit down upon comfortably. The dimensions shown are those which have proved satisfactory. The outer front of the rail if molded in panels will appear to better advantage than if left plain.

PIAZZA FLOOR

Fig. 11 shows a method according to which a porch floor was repaired. Every one knows how often the outer part of such a floor has to be renewed, this being most exposed to the weather. If this is replaced with concrete the less exposed part of the floor will last for many years. Perfect connection may be made between the concrete and the remaining wood-work.

Fig. 11 shows the method of repairing a porch having a 70-ft. front. The boards were cut back to within 3″ of the nearest joist in the sound portion. This part was blocked up securely and an outer wall of concrete built to replace the decayed front sill. A heavy shelf projecting inward was reinforced with pieces of iron rods, or any old iron pipe that came handy. The floor boards should project a short distance beyond the outermost joist running the length of the porch, and lag screws, spikes or bolts should be driven into the side of the joist so as to make a permanent connection with the concrete. This will readily be understood after a glance at Fig. 11.

Proper color may be given to the upper surface of the concrete by applying a finishing layer of about ¾″ of a mixture of sand and cement, 2 of sand to 1 of cement, with five lbs. of lampblack to a bag of cement and 200 lbs. of sand will give a slate color which will about match the color of paint frequently used on porch floors. No attempt should be made to paint the concrete itself. (Unless a special concrete paint is used.—Editors). It is not well to use a cheap grade of lampblack, which is frequently mixed with ground coke, or similar cheap forms of carbon. Such poorer grades of lampblack do not have the coloring power of a better quality and really cost more in producing the desired effect.

Tile flooring may be imitated and a pleasing appearance given to a concrete floor by using ½-in. strips of wood to mold grooves about ½″ deep in the still plastic floor. These may be withdrawn before the concrete has fully hardened and the grooves filled flush with a sand and cement mixture to which a terra cotta color has been given by a 2% to 5% (by weight of the cement) of red mineral color. This is very cheap and as sold in a dry, finely ground condition may be used as required to modify the color of concrete, as for instance that of the table top previously described.

An appearance of large stone slabs or flagstones is commonly given by molding grooves or indentations. These, however, when left unfilled, catch dirt. In finishing a fireproof laboratory, where absence of dirt or dust was essential, the writer found that a floor, made as described, imitating tiles about 10″ square, was not only pleasing in appearance, but easily kept clean.

It may be noted also that in drilling holes for bolts to hold together parts of iron reinforcing framework they may be conveniently drilled even after such parts are in place, by using an attachment to an common carpenter's brace. It takes the place of an ordinary "bit" and has a short piece of chain which is passed around the bar, beam, or other part to be drilled and hooked back to the tool This holds the drill to the work without the labor of pressing it and the tool feeds itself in, automatically Several varieties of this device are on the market and to be found in well equipped hardware stores

In this way holes which could not be conveniently located before erecting an iron frame can afterward be easily drilled.

Most people shy at whatever savors of the machinist's trade; but the metal working tools referred to in this article are inexpensive and can be used by any amateur, or "handy man," quite as easily as ordinary carpenter's tools. I should have added a "center punch" to the list, to be used in marking the exact spots to be drilled.

The skilled artisan will not need all the detailed instructions which have accompanied the foregoing suggestions.

That Good Roads saved the city of Paris at the time of the big German drive at the beginning of the present European war, is a statement made by Maj. Amos A. Fries, Corps of Engrs., U. S. Army.

Forms for Concrete—Their Construction and Movement on the Job

By Robert Sherwin[1]

The Apr., 1916, issue of Concrete *contained the first installment of a paper presented by Mr. Sherwin before the Am. Concrete Inst. at Chicago, Feb., 1916. The first section described the practical design of concrete forms and the present article describes the economical fabrication and routing of forms on building construction.*

SHOP WORK

The saw mill should be located, after a study of the job site, in a position where there is plenty of space for piling the stock and also the finished panels. The saw mill shed and equipment should be standard so that it can be erected and put in operation as soon as possible in order to reduce hand-sawing to the minimum. A saw mill at its best is dangerous. For this reason every precaution should be taken to protect the workmen by efficient saw, machine and belt guards. The mill should be near the building, so as to reduce the cost of moving panels. This moving cost is an important one in obtaining low erection costs and will amount to a considerable item when the mill is poorly located, either from lack of planning or from lack of space for the plant around the building.

The mill yard should be so arranged that the stock will go in one direction from the lumber piles to the saws, the making-up benches and to the finished panel piles, which should be nearest the building.

The lumber when received is checked as to quality and quantity. The stock is then sorted and piled according to size and length, each pile having its size plainly marked.

It is then an easy matter for the mill man to make a lumber ledger of all the stock in his yard. Thus at all times it is possible to know the stock is available, for as the lumber is used deductions can be made and the running total kept up to date.

The mill man divides the panel details up into boards to make the required width of the panel. The number of boards of each kind needed to make the number of panels wanted are ordered moved to the saw to be cut to proper length, and thence to the make-up bench, where cleats of the proper size and length are already waiting, having been previously ordered through the mill. Another order to the bench carpenters, which is clipped to a blue-print sketch of the panel, enables them to cleat together the boards into the finished panel. The panel is then taken away by a laborer, stenciled with its location mark, oiled and piled until ready for use in the building.

All this is done by orders written on standard order forms of three kinds, one for moving the stock, another for sawing and the last for making up. Duplicates of the orders are placed on the mill man's progress board so that he knows at all times how the work is progressing, for when an order is completed and returned to him its duplicate is taken down. Each kind of order is of different color so as to be easily identified.

There are several points in connection with making up panels which may be considered here.

As much assembling as possible should be done at the bench. Rangers for wall beams can be attached and ledgers to support joists can be nailed to the interior beam side cleats at the proper depth. When inserts need to be placed in the sides of beams, the holes for the bolts to hold them can be located on the details and the holes bored at the mill. The groove strip for steel sash and also the corner fillet can be put on the column sides and beam bottoms. Bevel key strips for walls should also be nailed lightly to the panels when necessary.

Heavy cleats for big wall columns should be cut and bored, but not attached to the panels. The panel can be cleated with 1¼-in. boards, and is thus made much lighter and easier to handle in erecting. Clean-outs at the bottom on two opposite sides of all columns should be made at the mill. Reduction strips should be nailed at the edge of all panels which reduce in size when re-used.

All small pieces liable to get lost or used for other purposes can be dipped in red paint so that their small size will be respected by the carpenters when looking for loose boards.

Much waste in making up ⅞-in. panels can be prevented if the floor is laid out so as to make the majority of the panels a whole number of boards wide. Roofers come 5⅜" to 5½" wide, and it is an easy matter to plan the panels to come, say, seven boards or eight boards wide, which means no waste in ripping one board to make the width. The length should be planned as near stock lengths as possible. Panels made of spliced boards are expensive to make and easily broken.

It is not economical in labor to make up panels from lumber which has already been in contact with concrete several times. On a large building recently erected by us the average cost of making all panels from new stock was $1.10 per square. On another building of exactly the same type the average cost of making all panels was $1.43 per square. On the latter building old lumber from the first was re-used in making a large part of the panels. These prices include oiling, lumping, saw filing, carpentry, sawing and job mill overhead.

If, however, panels are in good condition they can be cleaned and repaired at a considerable saving, both in labor and material. As an example, 13,562 sq. ft. of ⅞-in. floor panels were cleaned, repaired, cut to a new length, oiled and piled; 6,560 sq. ft. of 1¼-in. column sides were cleaned, repaired, oiled and piled; 1,250 sq. ft. of column heads were cleaned, repaired, oiled and piled, at a total cost of $99.25, or a unit labor cost of $0.00466. The estimated labor cost of making the above forms from new stock, using unit costs obtained on the same work, was $178.20, or a saving of over 40% in labor, besides a big saving in material.

Old 1¼-in. panels can be knocked to pieces, the boards cleaned and piled for about $3.00 per 1,000 ft. b. m. Large quantities of typical forms can be made from these boards at a slight increase in labor cost over using new stock. The lumber saving is considerable. The quantity made must be large to allow a thorough routing of the old stock through the mill.

The cleat spacing for the various kind of panels should be kept uniform so that the strips on the benches, for spacing the cleats, will not need to be moved for every set of panels.

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[1] Res. Engr., New Haven, Conn., for Aberthaw Constr. Co.

For beam sides 2-in. x 3-in. cleats can be used on panels up to 30″ deep; 2-in. x 4-in., flat, up to 42″, and 3-in. x 4-in., on edge, above 42″ deep. Nails should be specified about as follows:

No.	Size	Width of Board
3	10d	6¾″ and 7¾″
2	10d	2¾″ to 5¾″
1	10d	Less than 2¾″
..	12d	In 3 in. x 4 in. cleats
..	8d coated	In ¾ in. boards

Wire nails should be used for form work because of ease in driving and drawing. The holding power is also sufficient. Double-headed nails should be used in securing all boards which have to be loosened before stripping.

FIELD WORK

All work on the forms after the finished panels are piled at the mill will be called field work to distinguish it from the work in making up the forms, which has been called shop work. Under this head will come everything connected with using the panels on the building. An important feature of this work is a planning department, whose business it is to plan the work in advance so that at all times the several gangs will have definite tasks to do and be supplied with sufficient material with which to do the work.

An editorial in *The Contractor*[1] says in this connection: "This planning consists of many things. First, it demands complete plans and drawings for the work in hand. Plans cannot be made for building a structure unless the details of design have been prepared and from these the kinds and quantities of work are known." In the writer's own work, complete plans are rarely available when work begins and usually only very preliminiary drawings have been prepared. Nevertheless, the work should be planned, using experience on past work and available information on the job at hand as basis to work upon.

The moving boss has an important position in this field work. He is responsible for getting the proper panels to their correct location in the building and having all other stock called for on the assembly plan on the job ahead of the erection carpenters. When the forms are stripped, he must move the panels, which are to be re-made before their next use, to the re-making benches and thence to their next location. It is expensive to have high-priced carpenters waiting for stock or using stuff not suited for the job they have to do.

The erection of the centering and the assembling of the panels, after the later have been moved to their proper location in the building, is done by carpenters. It is economical to employ good carpenters and keep them employed constantly. A gang of men that understands form work on concrete buildings, the methods used and the grade of work desired, is a valuable asset for any firm specializing in reinforced concrete work.

A competent foreman should be in charge of all carpenter labor. He should be consulted by the planning department so that "team work" will prevail.

Quality in concrete building work is usually more desirable than low costs. Good lines and surfaces will be remembered after the cost is forgotten. These results can be obtained only by careful supervision of the erection of forms.

When forms are to be re-used, as is usually the case, stripping should be done as carefully as possible. An intelligent foreman in charge of a stripping gang is a good investment. Any man can wreck forms cheaply, but a man who can strip the forms and leave them in good condition for re-use is, in the end, the cheapest stripper. He saves the time of the high-priced carpenters in re-making and fitting broken panels.

The question of when to strip is one for the building designer to decide, and his instructions should be carefully followed. It is cheap insurance to make enough forms so that no chances need be taken of weakening the tructure by stripping while the concrete is still green.

The panels which need to be altered before re-use should be remade from the blue-prints showing the necessary changes. A bench for this purpose can be set up in the story where the forms are stripped. It is sometimes advisable in a high building to set up power saws in one of the upper stories for cutting off panels and getting out stock for re-making and repairing.

A large gang of carpenters working overtime is sometimes necessary in order to deliver a building on time. This is expensive, however. The workmen cannot give back in efficient labor the value of their high wages. Ten hrs. is about all the average man can work without falling off greatly in efficiency. Night work on forms should be avoided if possible.

When speed is not the essence of the contract, there is time to plan the erection work more carefully. Smaller gangs can be used and their tasks and material for them routed by slips similar to those used in making up panels.

STAGING

An important item in the field work is the erection of economical safe stages. These stages should be carefully designed as to the worst possible load to come upon them, and the design should be strictly followed in the field. A man thoroughly familiar with lumber should be made inspector as to the quality of the stock used for stages. A good stage makes the workmen more efficient and is a good insurance investment.

GENERAL NOTES ON FORM WORK

Keynotes to economy in a concrete building are regularity and simplicity. These two points, if borne in mind by the designer, make cheap forms. The latter should have the idea of forms as firmly in his mind as he does his bending moment formulas, if he is to turn out a good reinforced concrete design. Concrete used with brick curtain walls can be worked into very pleasing exteriors without the need of elaborate details requiring expensive forms.

Projecting belt courses break up the continuity of the exterior column forms and should be avoided except on very high buildings. A heavy overhanging cornice, consoles and brackets needed at the top of a tall building can be more cheaply made of sheet metal and attached to a plain concrete cornice beam by means of steel brackets. The effect is just as pleasing as if expensive forms are made and the concrete members cast.

The number of different sizes of beams, columns and thickness of slabs should be kept a minimum. This means fewer different kinds of units. The panels can be made and handled more cheaply, to say nothing of the time saved in designing. The biggest item of expense, however, is that of re-making beam and column forms and patching floor forms when changes occur in the size of the members on different floors. It may be nice to know, for instance, that an 18-in. x 18-in. column is sufficient to carry the load, but it is better to know that a 20-in. x 20-in. column, as used below, is the size to use ordinarily. This saves re-making the column sides and patching the beam and slab forms. In most cases concrete is cheaper than altering forms.

Stock sizes of lumber should be

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[1] May 15, 1915

kept in mind and when dimensioning the concrete members. For example, projections should be made 1¼″ and 1¾″ instead of 1″ and 2″, since dressed stock comes nearer the former sizes. Beams can be made 11¾″ wide instead of 12″. Thus one 12-in. plank can be used without needing a ¼-in. strip tacked to the edge. Points such as these, thought out in the designing room, mean a cheaper building.

It is economical on jobs where speed is not required to place concrete with light equipment and slowly. Lighter forms can then be used because the live load is greatly reduced when tracks and big cars do not need to be supported by the forms.

CONCLUSIONS

Much has been written, many experiments made and standards adopted in relation to concrete and reinforced concrete design. It is the writer's opinion that more accidents can be prevented and money saved by contractors and for owners by showing the same interest in the study of form work. The greatest proportion of the small number of failures of concrete structures is due either to faulty form design or because the forms were stripped too early.

Recently we have had reported in the engineering periodicals the failure of a concrete slab, resulting in the death of two workmen. According to an expert's report "the form supports were faulty." Forty-five sq. ft. of floor were supported on each post, made up of one long 2″ x 4″, to which were spiked short pieces of 2″ x 4″ to make up a 4-in. x 4-in. post. These posts had little bracing. Two floors of green concrete were supported on such posts. Is there any wonder that failure resulted?

As has already been stated, the unit cost of making a thorough study of forms for a job is difficult to determine, but it is small compared to the time saved in the field by using the more efficient methods. In spite of the fact that carpenters' wages have steadily increased, while the quality of labor has decreased, and a poorer grade of lumber costs more than a few years ago, unit costs on form work are much lower than when the job was left to itself. The overhead cost for this office work is a very small part of the total unit cost of the form work.

It is safe to say that by using methods such as have been described, a large saving is possible over doing the work by ordinary methods.

Some Data on the Use of the Cement Gun

The following data are from the *Reclamation Record* on the use of the cement gun at the Elephant Butte Dam:

The upstream face of the dam is being waterproofed with gunite mixed in the proportion of 1 cement to 2 sand and applied in a coating about 1″ thick. Advantage has been taken of rising water in the reservoir to work from rafts specially constructed for the purpose. There are two of these, each 9′ x 13′, made of planking on a framework laid on and attached to 16 oil barrels. One raft contains the machine, operator and helpers, small mixing box and a few sacks of cement and sand, while the other is loaded with cement and sand.

The coating is applied in horizontal strips about 10′ high and the length of the dam at water level. The surface is first cleaned thoroughly with scrapers and wire brushes and is then gone over with a sand-blast, using coarse sand, passed through the machine to obtain the necessary pressure. The surface is then thoroughly moistened with a hose and the mortar immediately applied. The mortar is put on in four layers, each about ¼″ in thickness. It was found that a thicker coat than this applied on a vertical wall, without reinforcement, would sag on account of its weight. Each layer follows the preceding one before it has attained its final set, and so far there is no indication of a parting of the layers. Numerous samples taken from the face showed perfect adhesion to the concrete, it being impossible in every case to break the mortar from the concrete at the line of contact. The cost per sq. ft. for the first 100,000 sq. ft. is as follows:

Operating and repair work, including cost of air and water	$0.015
Staging, cleaning wall, moving, etc.	.006
Cement	.024
Sand, including labor, screening and hauling (sand only 20 cts. per cu. yd.)	.007
Depreciation of gun and equipment	.020
Sub-total	.072
Overhead	.007
Total	.079

Some experiments were also conducted at Elephant Butte to determine the feasibility and probable cost of troweling the mortar placed by cement gun. This with the idea of using the machine for the lining of canals or for repairing lining that had disintegrated and required a smooth finish. The area treated was 75 sq. ft. This was covered with mortar, averaging ¾″ thick, in 15 min. working time, or at the rate of 300 sq. ft. per hr. for this average thickness. One good finisher troweled 56 sq. ft. in 25 min., or at the rate of 135 sq. ft. per hr. Possibly two men could keep up with the gun. The finishing was not done to a screeded surface. The surface is wavy, but much smoother than a formed surface would be. It could be screeded to a plane, if thought necessary. Care must be taken that too much material is not deposited in one coat, or horizontal cracks will occur, due to settlement. Some cracks appeared in this experiment, and in each one the material was found to be from 1″ to 1½″ thick. The cost of this particlular experiment, not counting cost of setting up, equipment, etc., was as follows:

Labor	$0.30
Sand, approximately 9 cu. ft.	.90
Cement, 4 sacks	2.00
Total for 75 sq. ft.	3.20

Or 4¼ cts. per sq. ft.

Depreciation, staging, moving, etc., would depend on the job, but it is probable that the total cost of placing this coating, including the troweling, under average conditions, would not exceed 5 cts. per sq. ft.

In using the cement gun the sand must be clean, sharp and not too fine. It must not be bone dry, or trouble with feeding will occur. The air pressure should be about 30 lbs. in the gun and water pressure over 60 lbs. It has been figured at Elephant Butte that 30′ of free air, at 100 lbs. pressure at the point of delivery to the gun, and 10 gals. of water are required per min.

The Life of Concrete

Chemical Abstracts publishes this summary of a paper by Bertram Blount, "Probable and Presumptive Life of Cements," from the International Engrg. Congress:

> The list of possible causes of destruction of ordinary concrete are bad cement, bad aggregate, bad proportions, bad mixing, bad workmanship, bad design, external violence, fair wear and tear, action of saline solutions, action of acids, electrolysis. For reinforced concrete in addition to the above causes there are corrosion of reinforcement direct or by electrolysis and cracking due to monolithic character or possibly to stresses between the concrete and the reinforcement. Of the external causes of destruction the most important is the action of saline solutions. The action of acids (notably H_2SO_4 and H_2S) is next in importance, and finally electrolysis is an important agency in destruction. A plea is made for rich, dense, impermeable concrete which is as impervious as possible to the entry of air and water. Electrolysis can be avoided by proper insulation. Any structure made well and honestly enough will vie in life with the mighty structures of antiquity.

Construction of a High Concrete Tank at Knoxville, Tenn.

By Robert Lindsay Mason

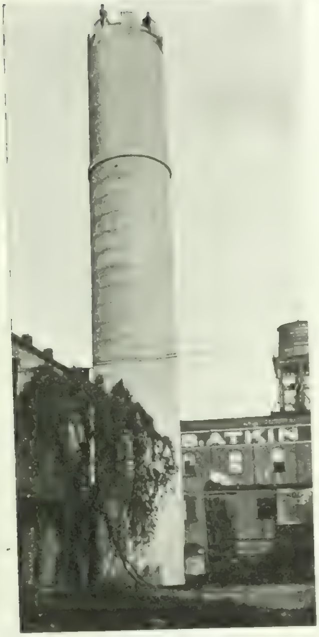

Fig. 1—A 124-ft. Water Tower at Knoxville, Tenn.

A modern concrete water tank 124′ high has been built recently at Knoxville, Tenn. This tank, of 40,000 gals. capacity, will supersede two wooden roof tanks and provide reserve for future needs.

The permanence and fireproof quality of this tank and the small ground area it requires are strong arguments for more extended use of this type of structure.

The outside diameter is 17′ 4″. Other dimensions are: Depth of foundation 4.1′, top of foundation to tank bottom 92.6′, tank bottom to roof 27.1′, roof to top of battlement 4.2′, total height 128′.

The foundation rests upon red clay, of which the usual safety tests were made. It is spread so as to allow a uniform load of 3,000 lbs. to the sq. ft. and consists of a ring base 6″ wide and 4′ deep, placed so as to rest directly under the center of the tower wall. The reinforcement of this base consists of ⅝-in. twisted steel bars placed radially 4″ o. c. to take care of bending moment caused by the superimposed load and wind pressure, while six concentric rings of ⅝-in. bars were spaced 12″ o. c.

Walls of the supporting tower to the bottom of the tank are 8″ thick, reinforced horizontally and vertically with ⅝-in. twisted steel bars spaced 18″ o. c. each way. Additional bars were embedded from bottom of foundation to a height of 30′ to take care of wind stress and unequal settling.

As the windows of an hotel are only a few feet from the work it was necessary to do most of the filling of forms between sleeping hours. A steam turbine hoist was used and the breakdown of the boiler during the laying of the tank floor required the men to be employed for 21 hrs. at one time. The engineer recommends any form of electric hoist when conditions of a similar kind are encountered on account of its comparative noiselessness. The tank floor is 14″ thick at the center and 21″ at the circumference reinforced with ¾-in. twisted steel placed at right angles so as to give an 8-in. mesh. A 21-in. coping with 4-in. overhang outside added to the symmetrical appearance of the structure. The walls of the tank are 6″ thick with ⅝-in. and ½-in. steel bars spaced horizontally 4″ to 12″ o. c., with vertical bars 18″ o. c.

The roof slab is 5″ thick at the center and 4″ thick at the circumference. Its reinforcement is ½-in. twisted steel bars spaced at right angles to give a 12-in. mesh.

On the perimeter of the tank roof was built a battlement as a railing and finish to the whole. A brush coat was given to the completed structure and a steel ladder 100′ long reaching to a walkway was anchored tightly into place with screw anchors.[1]

Little sand was used in the concrete. Instead of sand "chats," a dolomitic limestone, a by-product of zinc mines, was used because the engineer found that it produced a stronger concrete. A mix of 1:8 was used in the foundations and 1:6 in the tank proper.

Steel forms[2] were used in the construction of this tower and were supported by a 4-in. steel center mast so that no part of the weight rested upon the green concrete. A mast 75′ high was used in building the Knoxville tank and was shored up on two 8-in. x 10-in. beams resting in wall apertures 50′ from the ground for the higher work. In the mast are holes 8″ apart for the insertion of a pin which supports the form at any desired height after it is raised by the means of jacks. The forms were lightly brushed with crude petroleum so as to insure removal from hardened concrete without difficulty.

When loaded, the Knoxville tank exerts a weight of 500 tons on the foundations. The total time of construction was 54 working days.

One incident threatened to mar the erection of the tower with a fatality. While laying the roof of the tank at an elevation of 120′, a defective piece of timber suddenly gave way just as the last bucket of

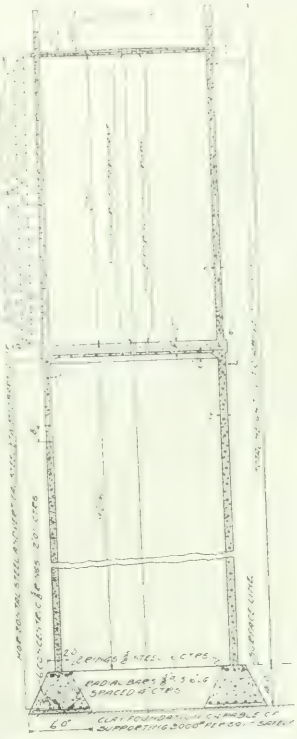
SURFACE LINE
RADIAL BARS ⅝
SPACED 4″ CTRS
CLAY FOUNDATION CAPABLE OF
SUPPORTING 3000# PER SQ. FT. SAFELY
6′0″

Fig. 2—Section of Tower and Tank

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[1] Richmond Screw Anchor Co., N. Y. C.

[2] Polk, Genung, Polk Co., Fort Branch, Ind.

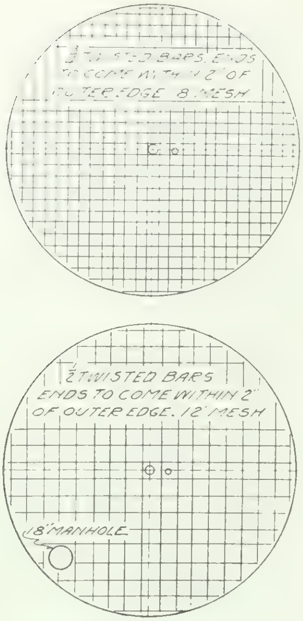
3/8" TWISTED BARS, ENDS TO COME WITHIN 2" OF OUTER EDGE 8" MESH
1/2" TWISTED BARS ENDS TO COME WITHIN 2" OF OUTER EDGE. 12" MESH
18" MANHOLE

Fig. 3 Reinforcing Plan of Tank Floor and Roof

concrete was being deposited. Eight tons of green concrete and twisted steel fell to the floor of the tank 27′ below. The two men employed upon the work barely escaped a nasty fall by clutching the iron rim of the form. This mass of debris might have caused serious damage to the tank floor but for the fact that the forms prevented the mass of material from falling simultaneously, thereby lessening the shock. After a thorough examination, no cracks whatever were found in the tank bottom, which was designed to support a weight of 300 tons. No inconvenience from the accident was occasioned except the loss of material and labor, and another roof was completed 48 hrs. after the accident.

A small amount of seepage which is not unusual in tanks of this sort was noticed on the sides of the tank after its completion but this was easily stopped with an application of cement plaster which was used inside the tank.

UNIT COSTS

Total number of yds. in foundation	31
Cost of excavating and placing foundation	$1.50 per yd.
Total number of yds. in base and tank	161
Cost of placing concrete	$1.74 per yd.
Total cost of concrete in structure	$6.52 per yd.
4.7 tons of steel in place complete	
Cost of placing steel in place	$24.25 per ton
Average cost of steel in place	$2.20 per cwt.
Contract price	$2,450.00

The use of steel forms reduced the usual cost of concrete in place about $6.00 per yd., as there were no form costs on this job except in the form of a nominal equipment charge.

The tank was built by James A. Higgs, Jr.,[3] for the Atkin Mantel Mfg. Co. and will serve the fire sprinkler system of both the factory and the Colonial Hotel adjoining, which are owned by C. B. Atkin.

Placing the Blame for Poor Work

Under the heading "Placing the Blame for Poor Concrete Work" the *Architect and Engineer of California* makes some interesting comments on the irresponsibility, frequently of the low bidder. The criticism follows:

> We hear a great deal about poor concrete construction due to incompetent handling. Just as frequently we hear the architect criticized for awarding a contract to an irresponsible cement man. Now, as a matter of fact, the real culprits, if culprits they may be, are neither the architect nor the engineer, but most frequently the corporation that sells the material, knowing, at the time, that it is bargaining with a weakling. If the manufacturer should decline to sell his product to this fellow unless he submitted satisfactory proof of his good standing financially and professionally, there would be very small chance for a failure. It would be up to the architect or owner to reaward the contract to a responsible bidder. The trouble heretofore has been that the manufacturers—both of cement and the machinery with which it is mixed—in their mad rush to corral the business, have been encouraging everyone who desired to go into business for himself to enter the concrete game. The general public seems to be firmly convinced that anyone who can build a concrete form, and that anyone who can turn a shovelful of grout can make concrete. To illustrate:
>
> Comes now John Smith, out of a job, or looking for new fields. He sees an advertisement for a block-machine, we'll say, which looks attractive. His order is promptly mailed and machine received. He borrows his neighbor's vacant barn for use as a shop, buys three or four sacks of cement from the lumber yard and has a load of sand sent up. Within a day he is making concrete blocks and has some letterheads struck off, giving his name as "general concrete contractor"—that always "listens" good. Meanwhile, Brown, the other concrete man in town, is figuring with Jones on the erection of a concrete block house; Smith hears of the job and goes after it. Naturally, he has no reputation to help him land the work (and none to sustain, either), so he plans his advantage from the low-cost standpoint; he bids two or three cents lower per block in order to get the first job and "show what he can do." Within a short time he is known as "Cheap John," is kept busy repairing his jobs, replacing poor material, and dodging his creditors. Finally his shop is closed, or Brown, whose business he has greatly injured, magnanimously buys him out.

This is not imaginary. Pity is, it's true. Not one concern alone is to blame, nor one man.

In a certain concrete journal,[1] September issue, there appeared a long article, illustrated, showing $20,000 worth of concrete culverts and bridges in the state of Iowa, which will have to be entirely rebuilt by their erectors because it wasn't "concrete for permanence."

We know of a certain county in Illinois where bids were recently opened for construction of a 12-ft. span bridge. The engineer's estimate was $1,140. Bidders were 11 in number. Bids ranged from a maximum of $1,350 down to $350. No amount of clean, square get-together could have changed that situation. The plain fact is that at least half the men bidding knew absolutely nothing about their own business.

How many manufacturers of cement and machinery take these facts into account? How many survey the field and, on finding that there are already too many engaged in the same line of business in their community, advise the prospective purchsaer to that effect? How many, on the other hand, are merely after the order, caring nothing about the future of the industry?

Relative Durability of Stucco and Staff

The question of the durability of the Fine Arts Palace of the Panama-Pacific exposition is one that has attracted considerable attention, and Bernard R. Maybeck, the architect of the building, has just made a statement in this connection. Prefacing his remarks by stating that there seemed to be a general impression that a large sum of money is needed in order to preserve the Fine Arts Palace, he says:

> The Fine Arts Palace is on U. S. property; eight columns and a piece of the altar are on Lyon street, San Francisco property. The foundation is on piles and good soil. The walls are of concrete. The roof is of concrete and glass. The building is absolutely fireproof. The construction of the rotunda and colonnade and decorations is of wood, very heavy on account of the great concentration loads. The colonnade was calculated to carry tons of wet earth, which was never put onto the roof. The Fine Arts Palace was constructed by the best engineers the Exposition company could find; if anything, it is too strong. If San Francisco were shaken by an earthquake the Fine Arts Palace would be the last to go. The staff work is cast. It is made of nephi plaster and wood fiber, is not put on with a trowel as on bungalows, but is stratified in the casting, like stone, and will not peel off. If the Fine Arts Palace were in another climate the ornamental surface would soon be destroyed by ice, snow and heat, but in San Francisco Mission Dolores still stands, made of mud and straw. If let absolutely alone the Palace of Fine Arts will outlast us. It has cost $700,000.

The interesting thing in this statement is the difference in the behavior of staff buildings on the Pacific coast from those in other parts of the country.

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[1] Concrete, Sept., 1915, p. 104

[3] C. E. and Contr., Knoxville, Tenn.

Design and Construction Features of a Sand and Gravel Storage Plant

By G. D. Crain, Jr.[1]

Several unusual features are embraced in the sand and gravel storage plant which has recently been put into operation by the Ohio River Sand Co. at Louisville, Ky. The plant, distant several miles from the company's yards, is designed for storage of materials for wagon hauling in that part of the city and for delivery to the street railway company, which has built a switch into the storage plant.

The plant is located on a spur of a belt line which passes around the city, so that deliveries to it may be made directly from the company's switch at its own yards, where railroad cars may be loaded, by steam railroad.

This plant consists of two cylindrical reinforced concrete bins, each supported on eight reinforced concrete columns, a reinforced concrete hopper into which the materials are dumped from railway cars, equipment for elevating the sand and gravel into the bins and spouting systems for discharging the contents into wagons or cars.

The capacity of each bin is 325 cu. yds. of sand or gravel and each of these bins is 20′ 6″ inside diam. and 25′ high. The walls have a uniform thickness of 8″ and the bottoms are sloped to facilitate discharging the contents of the tanks through the spouts, three of these being supplied for each bin, two to load wagons and one each to load cars. The bins rest on reinforced concrete columns; the distance from bottom of bins to top of column footings is 29′.

Across the top of each bin there is a reinforced concrete slab which covers the central portion of the bin, the slab being 5′ 6″ wide and 3″ thick. It spans the distance from wall to wall and is carried by 9-in. x 15-in. reinforced concrete beams, at the outer edges of the slab. Above the two bins, resting upon a portion of the top of the wall of each, is a concrete block motor house, enclosing a 30-h. p. motor, and other machinery required to operate the conveyor system. This house is about 10′ x 12′ and 8′ high. At the bases of the bins is the office and weigh room, constructed of concrete block.

DESIGN

In designing the cylindrical bins, the sand or gravel, was assumed to weigh 117 lbs. per cu. ft. The angle of surcharge and the angle of repose were taken as 28° minimum and 40° maximum, the angle of friction of gravel on concrete was assumed to be 31°. The computations as to lateral pressure on the circular walls were made according to the formula, $53.22\ h^2$ where "h" is the height in ft. The allowable compressive stress in the concrete was taken at 650 lbs. per sq. in. and the allowable tensile strength in the reinforcing steel at 16,000 lbs. per sq. in. The allowable bearing power of each concrete pile was 15 tons.

Figure 2 shows a cross-section of the reinforced bin, its principal dimensions, size and arrangement of reinforcement of the 8-in. walls, and the supporting columns and footings, together with the disposition of the slopes at the bottoms of the bins to facilitate spouting of the contents.

Figure 4 shows detail drawings of a beam, in the bottom of the reinforced concrete bin.

CONSTRUCTION METHODS

Some of the Simplex concrete piles[2] on which the concrete footings rest were driven 39′ below grade, footings and columns both being heavily reinforced. The illustrations show a foundation plan, the arrangement and sizes of the column footings and the concrete hopper at the elevation of the ground surface, the number and arrangement of the concrete piles, also details of the reinforced columns.

It will be noted that the hopper is spanned by a railroad track through which the sand and gravel are dumped and thence conveyed to the bins.

The construction company's plant on the ground included a 10-ft. Smith[3] mixer, with a wood tower by which the concrete was raised and

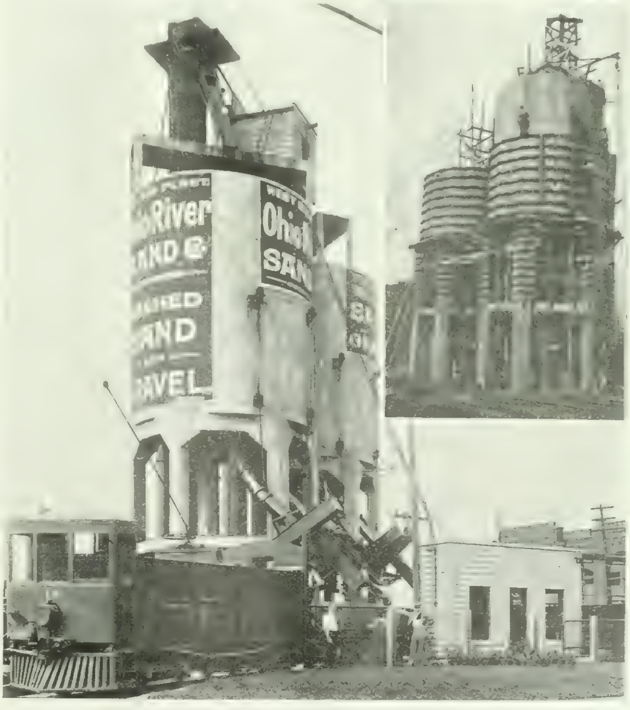

Fig. 1 Sand and Gravel Distributing Plant at Louisville, Ky.

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[1] Louisville, Ky.

[2] Simplex Concrete Piling Co., Philadelphia

[3] T. L. Smith Co., Milwaukee

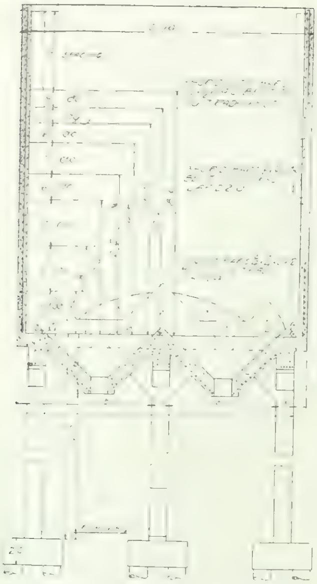

FIG. 2—SECTION THROUGH BIN SHOWING SLOPE OF BOTTOM AND REINFORCEMENT

chuted directly into the forms. This mixer had a maximum capacity of about 65 yds. per da.

Wood forms were used throughout in constructing bins and the column supports. The columns offered no

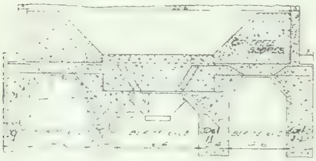

FIG. 4—SECTION OF CENTER BEAM

unusual problems, two-in. tongue and groove flooring being used. In making the forms for the bins considerable ingenuity was displayed.

The forms were cut at the contractors' mill, a total of two carloads of lumber being used. The flooring for the wall forms was braced with bands formed of 2-in. lumber cut to correspond to the curve of the bins. These pieces were sawed at the mill from 2-in. x 6-in. stock, the concave pieces being used for the outside bands, or hoops, and the convex pieces forming the ribs for the interior forms. With the uniform curves these segments could be overlapped as much or as little as proved desirable, and were nailed together at the ends, the walls of the forms being tacked to them from the inside. This made it possible for sections of the forms to be put together on the ground and assembled on the floors of the bins. The outer walls were further strengthened by steel hoops while bracing timbers were used on the inside. The required wall thickness was maintained by wood spacers from inner wall to outer, these being poured. The form construction is well shown by the illustrations.

Bins were poured in two sections; 14-ft. lagging was used for forms. Clean, sharp washed river sand and washed river gravel were used, with Kosmos Portland cement, the mix throughout being 1:2:4. Standard handling and quality specifications were adhered to throughout, the gravel being 3/4" or under. In pouring the concrete the engineer's directions provided that the concrete work between the spring of the girder haunches and 4' above this point or about 1' above the bottom of the tank wall, was to be poured in one operation.

Altogether about 1,000 cu. yds. of concrete were required for construction of the two bins.

MECHANICAL EQUIPMENT

The elevator equipment[4] raises the sand or gravel from the hopper into which it is dumped from the railroad cars. From this hopper a chain elevator, carrying manganese steel buckets, extends to the motor house on the top. The elevator is enclosed in a 4-ft. x 5-ft. boot, composed of 1/2-in. cast iron plates and made in sections of 13' each, the whole rising to a point about 82' above the hopper. At approximately this elevation the bucket elevator dumps into a small hopper from which the material is spouted into either bin, one being used exclusively for sand and the other for gravel.

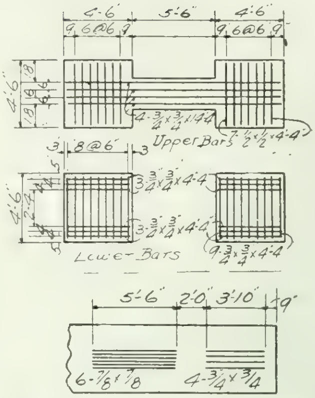

FIG. 5—DETAILS OF FOOTING REINFORCEMENT

COST

About four months were required to build the plant, which was constructed by the National Concrete Construction Co.[5] on a cost and percentage basis. With machinery equipment, estimating the sand and gravel at market prices, cost is said to be between $30,000 and $33,000.

As the aggregate was supplied by the owners it was decided to handle the work on a cost and percentage basis instead of by contract. All vouchers, bills, checks, payrolls, etc., were made out by the builders in duplicate and at the end of the month presented to the sand company, which gave its check for the

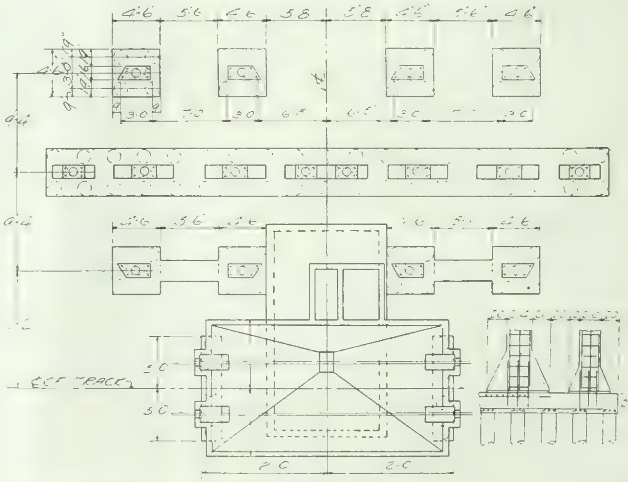

FIG. 3 FOOTING PLAN AND COLUMN DETAILS

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[4] Taylor-Warden Iron & Steel Co., High Bridge, N. J.

[5] Louisville, Ky.

total. When the work was three-fourths done a proportionate amount of the estimated commission coming to the builder was paid him and the remainder, figured on the total costs of the work, at the end. For this reason, as well as owing to the difficulty of going through all the records of the operation, as would be necessary, it is not possible to quote detailed costs of the various steps, which have not been computed. It may suffice to say that the costs were held down to a point satisfactory to the owners of the plant.

The plant, which has worked satisfactorily from the outset, has proved an excellent investment. With the low handling cost and reduction of the hauling cost and haul itself accomplished, the company has been in position to handle many orders which otherwise might have been out of reach. The plant is close to a section which is rapidly building with homes and factories and much of the building material passes through this plant, while the Louisville Ry. Co. has been equipped to haul sand and gravel from this plant not only to its own work in the city but to the builders located on the interurban lines of the company.

Replacing the Old Porch

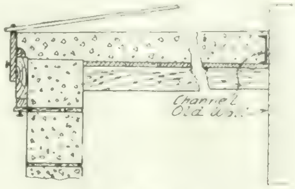
The most troublesome parts of residence property to keep in repair, with the possible exception of the roof, are the porch and the steps; a carpenter replacing this part of a house is a common sight. The concrete porch is becoming appreciated and the concrete contractor should be able to secure his full share of repair work.

The foundation should be carefully considered and a trench wall or piers sunk to sufficient depth to be below frost and on solid ground. Above ground to the level of the under side of the floor, the wall can be poured in forms or laid up with block or other units.

The floor is sometimes laid on fill—if this is done the fill must be placed in thin layers well wet down and very thoroughly packed. A floor on fill should be reinforced to take care of strains caused by unven settling.

More often it is economical and satisfactory to build a reinforced concrete slab without fill. It is something of a problem properly to support the slab next the building, as usually there is no wall or pier available. This can be satisfactorily accomplished as follows: Secure a piece of channel iron of a size sufficient to support the slab on the required span and cut a hole in the house foundation wall. The channel will be supported on the foundation walls of the house and porch. Use a channel or an angle iron next the wall of the house at right angles to the first channel, support it on the porch wall and the lower flange of the first channel. Where the porch is long and must be divided into several slabs, reinforced concrete beams can be built from the front wall to the house wall, and channels or angles along the house wall placed so as to be cast into the beams at intersections.

Another way that will prove satisfactory is to use T irons as transverse supports, cutting the joists between the slabs directly over the web of the T. Do not use a channel or an I, as it is impossible to secure a satisfactory floor over the upper flange.



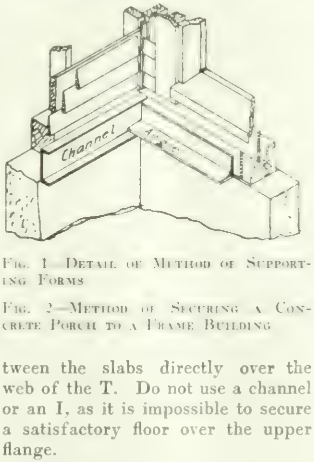


Fig. 1—Detail of Method of Supporting Forms

Fig. 2—Method of Securing a Concrete Porch to a Frame Building

Floor forms are now placed under the steel and can be built of waste lumber, as the appearance of the under side of the slab is of no importance. They must be strong—able to support the wet concrete without springing. Forms are placed for the edge of the floor slab, which should in most cases project beyond the edge of the foundation and the balustrade, for proper appearance, although in some cases the foundation wall and the balustrade are continuous and the porch floor is laid entirely inside the wall.

BUILDING THE FORM

When the wall is poured in forms it is an easy matter to build the form for the floor projection, but the problem of securing the form to walls built of block or with a hollow wall machine is less obvious.

It is easily accomplished, however (Fig. 1). When laying the wall the last course of block or concrete is built over pieces of wood lath which project about 2″ from the face of the wall. These support a strip of wood with its upper edge at the proper height to carry the overhang. It may be necessary to use blocks under the strip and tacked to it to adjust it to the exact height. A nail is driven up through the lath, effectually securing the bottom of the form in position against the wall. Molding or strips can then be built up to the form desired and the top of the form secured by stays to any available point of support.

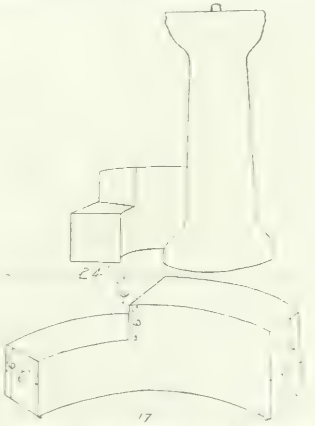
REINFORCING

The type of reinforcing to be used for porch floor slabs varies with the extent and shape of the work, size of slabs and form of reinforcing most easily obtained.

For a long narrow piazza, where the floor is carried on reinforced beams or T irons, it is probable that a wire mesh would be most economical and easily placed. For a wide short porch rods in both directions would probably prove the better method.

Concrete Step at Drinking Fountains

The accompanying illustration is from a sketch by C. N. Wiley,[1] who suggests the use of a concrete step to enable children of different heights to reach the water.



Concrete Step for Drinking Fountain

Such steps are being used to some extent and are a great convenience.

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[1] Royal Portland Cement Co., Birmingham, Ala.

Reports of Committees, National Conference on Concrete Road Building

A consideration of the reports of Committees 14 to 17, inclusive, of the Second National Conference on Concrete Road Building completes the reports abstracted in the Mar., 1916, and the Apr., 1916, issues.

Committee 14—Methods and Costs of Maintenance

Chairman, A. H. Hinkle;[1] L. C. Herrick,[2] John W. Mueller,[3] Maurice Hoeffken.[4]

A part of the report of the Committee on Methods and Costs of Maintenance is taken up with an article by A. H. Hinkle, chairman of the committee, describing in considerable detail repair work by the Bur. of Maintenance and Repair of the Ohio State Highway Dept. The recommendations for repair and maintenance as embodied in conclusions of the committee's report are based practically on the Ohio work. The conclusions of the committee are stated in abstract as follows:

CLASSES OF DEFECTS

The method of making repairs to a concrete road will depend upon the nature of the defects.

The nature of defects which determine the methods to be used in repairing them may be classified under five different heads as follows:

(a) Joints and cracks.

(b) Small holes (frequently caused by pieces of wood or clay in the aggregate, which might be as well classified under "a"), and shallow depressions, the latter not exceeding ½" to ¾" in depth.

(c) Depressions in the surface deeper than those described under "b," which cannot be successfully filled with a layer of tar covered with sand.

(d) Broken-up portions of the pavement which require replacement with new concrete.

(e) Where the entire surface is disintegrated or of such quality that it will not meet the demands of the traffic which are to come on it and hence must be resurfaced with tar and sand or some form of bituminous concrete.

While there is no doubt as to what work would fall under Class (a) and usually no question what would should come under Class (b), it is quite evident that many repairs must be made either according to Method (c) or Method (d), depending on circumstances. Conditions might be such that it would be more economical and practical to maintain a tar macadam patch than to replace the defective pavement with new concrete, even though the defective portion be of considerable size. Also when to use Method (e) is a question for debate.

REPAIR METHODS

(a) Joints and cracks can be successfully treated by thoroughly cleaning them and filling when dry, and preferably during warm weather, with hot tar, then covering with dry sand or screenings. The tar should be permitted to lap over the spalled edges of the crack, but not to exceed 1". The most desirable covering is clean, coarse sand or clean screenings of stone, slag or gravel, that will pass a ½-in. circular opening, and be retained on a 3/16-in. mesh screen. Experience has shown that the grade of tar which gives best results for this is one that will pass a specification similar to that for Bituminous Material, T-1, is given in Part 2 of this report. The tar should be poured when hot enough to run readily into the crevices of the pavement (about 200° F. to 250° F.). It is believed that no large excess of the tar should be used, as the frequent use of such an excess might eventually build up an elevation on the surface which would be objectionable to traffic. The covering of screenings or sand should be put on immediately after pouring the tar so that while in the liquid state it will unite with the screenings or sand in sufficient degree to prevent the tar from sticking to wheels of vehicles or melting during hot periods and running from the cracks.

The use of a mastic consisting of a mixture of hot tar and sand, in place of pure tar, for filling the cracks and joints, gives promise of excellent results; but perhaps it is too soon to give definite specifications for this mixture. The filling of the larger and more open cracks or joints with the mastic and the use of the pure tar for filling the minor openings in the pavement and such as are made necessary by settlement after the joints have been originally filled with the mastic, may be found to be most satisfactory.

A pouring can with a round or vertical spout is very satisfactory for pouring tar in filling cracks and joints. Inasmuch as it is desired that the tar shall lap over the edges of the crack or joint, the use of a conical pouring can would be of doubtful economy.

(b) Small holes and shallow depressions can be successfully treated as follows: Clean surface thoroughly. Where the surface is disintegrated, it should first be thoroughly swept with a steel broom in order to remove all loose spalls or foreign matter; afterward, the dust must be removed by sweeping with a rattan or house broom. The hot tar (T-1) is then applied to the dry concrete and rubbed well with a squeegee or stiff broom to secure a good bond to the surface of the concrete. The tar is then covered with coarse sand or screenings (½" to 3/16") of stone, slag or gravel. The amount of tar used will vary from ½ gal. to 1 gal. per sq. yd., depending upon the depth of the depression to be filled. Where more than ½ gal. per sq. yd. is used, it should be applied in two coats and the excess screenings swept off before the second coat is applied. The more tar that is able it is to have the coarser material applied to the surface, the more desirfor a covering. In filling small holes the application of the tar in two layers would, of course, be unnecessary.

(c) To repair larger holes and deeper depressions than those discussed under (b): Thoroughly clean and paint the surface with tar (T-1). Fill the hole or depression with broken stone, preferably of such size that they will not exceed in diameter ½ the depth of the depression to be filled nor exceed in size stone suitable for an ordinary tar macadam. The stone should be leveled off and compacted as well as may be by tamping or rolling so as to conform to the true surface of the road. The voids are then filled with the hot tar and screenings applied to the surface, which is again compacted and treated as in building a tar macadam. (Penetration Method.)

The use of a cold mix consisting of clean, hard stone chips coated with a coal tar cutback, for filling such holes and depressions, as described under the above paragraph, has been followed to some extent, with very promising results. The stone chips are first thoroughly coated with the cold tar preparation by turning with shovels after the tar has been sprayed upon them, as in mixing ordinary cement concrete. The mixture is then permitted to stand a few days until the lighter oils vaporize from the tar, which leaves the stone coated with the heavy tar. The coated chips are then well tamped into the hole or depression to be filled, the shallower depressions being first painted with the pure tar. Coarse sand or fine screenings are then spread over the surface. If the voids appear quite open after the coated chips have been thoroughly tamped, a light application of the tar is made to seal up the voids before the surface screenings are applied.

(d) Where the pavement is disintegrated badly or broken clear through so as to require re-building, it should be cut away with vertical edges. After the sub-grade is leveled and compacted and the edges and the sub-grade thoroughly dampened (but the foundation not made muddy), the part cut away is replaced with new concrete conforming in quality as nearly as possible to the concrete of the surrounding pavement. It is well to coat the edges of the old concrete with cement grout. Care should be taken that the surface of the new concrete conforms to the surface of the adjacent concrete. The new concrete should be kept well dampened for about 7 das., and protected from traffic (10 das. in warm weather and much longer in cold weather) until thoroughly hardened. If the replacement is over an excavation the concrete should be properly reinforced.

(e) The use of a tar top over the entire surface to protect and maintain a *good* concrete road is not necessary and is of doubtful economy. It may be desirable and economical to maintain such a top on a concrete road not made of first class concrete. While such a tar top has in the majority of cases proven a failure, many instances exist where it has stuck well, which seems to indicate that if the right grade of material is applied to a suitable surface in the proper way, good results will be secured.

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[1] Deputy Highway Commr., Ohio State Highway Dept., Columbus, Ohio

[2] Co. Engr., Huron Co., Norwalk, Ohio

[3] C. Engr., New Castle, Ind.

[4] Hoeffken Bros. Supply & Const. Co., Contrs., Belleville, Ill.

It is very necessary that the surface be thoroughly dry and properly cleaned before the tar is applied. It may be advisable to rub the surface well with a steel broom upon which considerable pressure is brought to bear, in order to remove any laitance and the film of "dead" concrete frequently found on the surface of the concrete, especially that which has not been properly protected against too rapid drying. If traffic is allowed to use the surface a few months this film would be ground off. The dust should then be removed by carefully sweeping with house brooms or some more satisfactory method.

There seems to be some question as to the grade of tar to use for this purpose. Material as heavy as that passing the specifications for Bituminous Material T-1 has been used, and material as light and even lighter than that passing the specifications for Bituminous Material H. T-1.

SPECIFICATIONS FOR BITUMINOUS MATERIAL H. T-1

HIGH CARBON TAR

Bituminous material H. T-1 shall include only coal tar products which shall meet the following requirements:

(1) The tar shall have a sp. gr. of not less than 1.18 nor more than 1.250.

(2) On extraction with carbon disulphide it shall contain not more than 20%, nor less than 10% free carbon.

(3) Upon ignition it shall show not over 0.5% inorganic residue.

(4) The consistency as determined by the Howard & Morse float apparatus at a temperature of 32° C. shall be not less than 2 min. nor more than 3 min.

(5) When distilled by the method proposed by the Am. Soc. for Test. Mat. not over 1% by weight shall distill below 170° C., not more than 16% by weight shall distill below 270° C., and not more than 24% by weight shall distill below 300° C. The residue of the entire distillate shall be not less than 1.03 at 25° C. The residue from the foregoing distillation shall have a melting point not greater than 75° C. by the cube method.

(6) The tar shall be free from water and shall not foam when heated to 275° F.

(7) All bituminous material used in a given construction shall be uniform in character, appearance and viscosity.

SPECIFICATIONS FOR BITUMINOUS MATERIAL T-1*

HIGH CARBON TAR

Bituminous Material T-1 shall include only coal tar products which shall meet the following requirements:

(1) The tar shall have a specific gravity of not less than 1.200 nor greater than 1.270 at 25° C.

(2) On extraction with carbon disulphide, it shall not contain more than 22% nor less than 10% free carbon.

(3) Upon ignition it shall show not over 0.5% inorganic residue.

(4) The consistency as determined by the Howard & Morse float apparatus at a temperature of 50° C. shall be not less than 2 min. nor more than 3 min.

(5) When distilled by the method proposed by the Am. Soc. for Test. Mat., it shall yield no distillate at a temperature lower than 170° C., not more than 10% by weight shall distill below 270° C., and not more than 20% by weight shall distill below 300° C. The sp. gr. of the entire distillate shall be not less than 1.03 at 25° C. The residue from the foregoing distillation shall have a melting point not greater than 75° C. by the cube method.

(6) The tar shall be free from water and shall not foam when heated to 300° F.

(7) All bituminous material used in a given construction shall be uniform in character, appearance and viscosity.

Whatever grade of tar is used it is quite evident that the results will depend largely upon the amount of material applied, up to a certain limit of course. Experience seems to show that ½ gal. per sq. yd. is none too much. The tar should be applied in two applications, the surplus screenings being swept off before the second application of tar is put on. Sufficient screenings should be applied to the surface to prevent the tar from sticking to the wheels of vehicles. It will be necessary to have available and apply on hot days additional screenings, once or more in the first hot period following the original application. Hard, clean screenings of gravel, stone or slag passing a ½-in. circular opening and retained on a 3/16-in. mesh screen are suitable for this purpose.

The possibilities of using an old concrete pavement which is cracked and worn so as to be quite unserviceable, as a foundation for some form of a bituminous concrete surface, or rein-

TABLE 1—TAKEN FROM 1915 ANNUAL REPORT

CONCRETE ROADS REPAIRED BY OHIO STATE HIGHWAY DEPARTMENT

PAVEMENT						AMOUNT EXPENDED From Nov. 16, 1914, to Dec. 31, 1915				
Year Built	County	Road No.	Section of Road	Length, Mi.	Width, Ft.	Roadbed	Surface	Bridges and Culverts	Supt.	Total
1915	Ashtabula	150	H	5.00	16	$93.33	......	......	......	$93.33
1912	Ashtabula	151	E	1.61	16	......	$215.92	......	......	215.92
1914	Coshocton	150	B	1.34	16 & 20	49.88	61.85	....	$119.93	38.53
1913	Erie	3	E	1.00	12	20.75		......	......	20.75
1913	Erie	288	D	1.00	10	....	18.75	......	......	18.75
1913	Franklin	19	D 3	2.85	14	67.50	....	......	......	67.50
1913	Geauga	15	E 2 D & E	2.80	14	189.05	89.51	......	14.00	292.56
1915	Geauga	15	G	2.45	10	7.00	......	$1.25	......	8.25
1915	Guernsey	349	J	0.69	14	......	10.40	......	......	10.40
1914	Huron	290	G	2.60	14	1,840.14	150.00	......	142.15	2,132.29
1914	Huron	290	H	2.58	16	43.00	50.00	......	7.00	100.00
1913	Huron	290	A	1.25	10	1,673.00	100.00	......	127.00	1,900.00
1914	Huron	289	J	1.63	16	30.91	119.30	......	10.70	160.91
1914 & 1915	Licking	1	G	13.83	16	......	21.25	......	......	21.25
1913	Licking	47	F	3.92	16	......	125.06	......	......	125.06
1914 & 1915	Lorain	3	J	5.62	14	1,675.94	......	......	110.85	1,786.79
1914	Lorain	290	K	0.65	16	44.60	......	......	......	44.60
1914	Lorain	291	G	1.35	12	......	43.75	......	......	43.75
1913 & 1914	Meigs	95	H & I	3.19	12	1,336.59	114.27	......	290.24	1,741.10
1912	Mercer	211	A	1.60	14	220.88	17.78	......	41.97	280.63
1912 & 1913	Miami	245	A	6.00	16	4.60	105.46	......	75.50	185.56
1915	Monroe	7	F	1.08	14	4.25	......	......	......	4.25
1914 & 1915	Muskingum	1	I	10.12	16	......	457.13	......	59.16	516.29
1912	Muskingum	344	K	1.55	14	160.99	100.00	......	40.00	300.00
1912	Muskingum	344	E	1.07	16	22.74	257.78	......	55.80	336.32
1912	Muskingum	351	M	1.32	14	31.00	26.01	......	11.25	68.26
1912 & 1913	Pickaway	10	A	0.97	20	125.90	140.77	......	1.15	267.82
1913	Pickaway	10	C	1.06	16	66.80	116.74	12.00	......	195.54
1914	Portage	324	H	1.62	12	110.50	57.13	......	20.00	187.63
1914	Portage	326	G	3.94	12	346.50	2.59	......	35.50	384.59
1913	Putnam	134	C	0.41	16 & 20	......	28.00	......	......	28.00
1912 & 1914	Ross	5	A & H	1.83	16	161.26	123.61	......	111.10	395.97
1914	Ross	5	G	0.60	16 & 20	......	27.75	......	21.50	49.25
1912	Ross	29 & 453	C	1.31	16	2.00	174.56	......	111.06	287.62
1914	Ross	258	E	1.00	16	......	85.00	......	29.50	114.50
1914	Ross	361	F	1.00	16	5.75	81.77	......	10.50	98.02
1913	Ross	365	B	1.00	16	......	56.62	......	25.25	81.87
1913	Sandusky	277	A 2	2.18	16	......	31.36	......	......	31.36
1914	Sandusky	277	C	1.09	16	......	15.69	......	......	15.69
1913 & 1914	Summit	98	E	2.38	14	66.56	223.87	......	64.00	354.43
1913	Trumbull	13	B	2.69	12	3,295.25	150.00	148.22	154.00	3,747.47
1912	Washington	7	E	1.00	16	80.00	18.00	4.68	54.00	156.68
1914	Washington	7	F	1.27	16	28.00	23.50	......	13.75	65.25
1914	Washington	7	G	1.29	16	51.25	121.09	3.50	21.25	197.09
1914 & 1915	Washington	393	I	2.23	16	35.75	76.98	......	23.50	136.23
Grand Totals				107.11	..	$11,891.67	$3,639.25	$169.65	$1,801.61	$17,502.18

*Includes .42 mi. of brick. Total mi. 127. 37. No work done on 20.26 mi.

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*This grade of tar corresponds very closely to Tarvia X of the Barrett Mfg. Co.

TABLE 2—SOME COST DATA SHOWING THE RELATIVE EFFICIENCY OF DIFFERENT METHODS OF MAINTAINING CONCRETE PAVEMENTS BY FILLING CRACKS AND JOINTS WITH BITUMINOUS MATERIAL

PORTABLE HEATING KETTLE USED

	Conditions						Cost of Labor			Materials					
County	Section	Built	Width	Sq. Yds. (a)	Total Length in Ft. of Cracks and Joints (b)	Expression of Discontinuity of Pavement, b/a	Skilled	Common	Teams, Freight Storage, Transportation	Bituminous Material	Sand and Stone	*Dep. on Equipment	†Supervision	Total Cost	Cost per Sq. Yd.
Cass	A	1914	10	7,279	917	.126	$11.00	$ 3.50	$ 9.96	$ 1.92	$ .60	$1.25	....	$28.23	$ .0039
Iroquois	A	1914	10	13,433	1,753	.130	3.90	4.80	8.85	5.17	.40	2.30	....	25.42	.0019
Iroquois	B	1914	10	14,784	1,980	.134	3.30	4.40	10.60	4.63	.42	2.60	....	25.95	.0017
Sangamon	—	1912	18	12,600	6,065	.472	10.00	17.67	11.25	20.87	2.00	1.21	....	63.00	.0050
Sangamon	B	1914	18	4,400	854	.194	5.00	7.30	8.75	3.75	...	.40	....	25.20	.0057
Sangamon	C	1914	18	4,400	577	.131	3.00	1.22	1.25	1.87	.20	.40	....	7.94	.0018
Sangamon	D	1914	18	4,000	774	.193	3.00	1.22	1.25	1.87	.20	.40	....	7.94	.0020
Sangamon	E	1914	18	4,700	690	.147	5.00	4.12	3.75	1.87	.30	.45	....	15.49	.0033
Menard	A	1914	10	2,667	290	.108	3.85	.70	3.61	1.25	.25	.45	....	10.11	.0038
											Average cost per sq. yd.—				$ .0032
				AUTO TRUCK USED											
Logan	A	1914	10	4,000	458	.115	3.00	2.00	.56	1.74	.10	1.40	....	8.80	.0022
Logan	D	1914	10	4,000	503	.126	3.00	2.00	.70	2.17	.10	1.40	....	9.37	.0034
Livingston	A	1914	10	13,810	2,240	.162	12.00	3.75	2.80	5.57	.50	4.70	....	29.32	.0021
Kankakee	A	1914	10	10,500	1,711	.163	14.00	4.00	1.30	5.30	1.00	3.60	....	29.20	.0028
Will	A	1914	10	10,666	2,000	.188	18.00	4.60	4.89	4.62	.20	3.60	....	35.91	.0034
Cook	E	1914	18	38,884	5,488	.141	21.00	8.00	4.54	8.92	.40	7.40	....	50.86	.0013
Cook	B	1914	18	14,222	1,821	.128	4.50	3.00	1.26	5.72	.10	2.75	....	17.33	.0012
Cook	A	1914	18	5,246	706	.135	1.50	1.00	.57	1.11	...	1.00	....	5.18	.0010
											Average cost per sq. yd.—				$ .0022

*Under depreciation $1.00 per mi. of pavement is charged against the portable heating kettle equipment and $2.00 per mi. for the auto truck

†The cost of supervision is pro-rated against the maintenance and upkeep at the close of the season

forced concrete surface, are very good. However, it is not believed that there should be any relaxation in carefulness to secure a good pavement in the first instance because of a possibility of utilizing it in this way.

Minor defects that appear in the pavement should be given attention at an early date in order to prevent more serious defects from developing. The pavement should be gone over and such minor repairs made as are necessary, at least once a year on light-traffic roads and twice a year on heavy-traffic roads.

The cost of maintaining concrete roads will vary inversely with the quality and uniformity of the concrete in the original construction; *so great is this relation that the importance of a properly constructed road in the first instance cannot be overestimated.* The increase in the life of the road and the great saving in maintenance cost by careful and proper construction will warrant, if necessary to get good work, the expenditure of no small amount of additional funds.

Reasonably accurate cost data for maintenance have not been kept over long enough periods to predict the average maintenance cost of concrete roads until they are worn out. The best available data seem to indicate, as a conservative estimate for roads that have been down from 1 yr. to 5 yrs., a maintenance cost of less than ½ ct. per sq. yd. per yr.

In the course of the discussion of the report of the committee, Mr. Hinkle stated that the cost of surface maintenance per mi. in the state of Ohio had been $29. Mr. Hinkle emphasized the importance of keeping figures on the maintenance of surface entirely separate from the maintenance of the other parts of the roadway. For instance, the floods in Ohio caused washouts in several cases, where the sub-grade had to be extensively repaired. This he said should obviously not be charged to surface maintenance. Another point partciularly mentioned in the discussion of maintenance is that some care should be taken in applying the hot tar to cracks. If it is allowed to pile up and spread out over the surface of the pavement for a greater area and to a greater thickness than is necessary, subsequent applications of tar over the fine crack which is apt to appear the following year, finally will give a thickness of tar and sand at that point which will cause a bump and gradually deteriorate the pavement at each side. Mr. Hinkle recommended that only so much tar as is necessary be put on and that it extend no more than 1″ on either side of the crack. The question was asked why subsequent applications of tar could not be removed and Mr. Hinkle stated that the cost of removing the tar will be greater than the additional cost of taking pains in applying it in the first place.

It was reported in the course of a discussion that at Gary, Ind., concrete patches are put in where necessary and traffic kept off 24 hrs. and asphaltic treatment applied; then traffic is allowed on the work.

Walls that are to be watertight should be monolithic, if possible; if not possible, all dirt and laitance should be removed and a layer of rich mortar placed before new concrete is poured.

Committee 15—Form of Specifications

CHAIRMAN, A. R. HIRST;[1] F. D. ROGERS,[2] C. D. BREED[3], F. C. WILSON,[4] R. D. BAKER.[5]

The report of the Committee on Form of Specifications was not completely formulated before the close of the Conference. It will be embodied in the official proceedings when these are issued. The report is of a nature which does not lend itself readily to presentation in abstract.

Committee 16 — Cost of Construction

CHAIRMAN, C. J. BENNETT;[6] H. ELTINGE BREED,[7] E. J. MEHREN,[8] C. U. BOLEY,[9] FRANK A. WINDES.[10]

In reporting on Cost of Construction the committee found such disparity in methods of reporting that comparisons were impossible. The committee found that there were few sets of figures that included the same cost items under the same headings;

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[1] State Highway Engr., Wis. Highway Comm., Madison, Wis.

[2] State Highway Commr., Mich. State Highway Dept., Lansing, Mich.

[3] Cons. Engr., Boston

[4] City Engr., Mason City, Ia

[5] R. D. Baker Co., Contrs., Detroit

[6] State Highway Commr. of Conn., Hartford, Conn.

[7] 1st Deputy Commr., N. Y. State Highway Comm., Albany

[8] Editor-in-Chief, *Engineering Record*, N. Y. C.

[9] City Engr., Cheboygan, Wis.

[10] Windes & Marsh, Winnetka, Ill.

therefore, in its report the committee not only presents some typical cost data from various localities without any attempt at comparison but it presents a proposed uniform cost sheet. Some of the cost figures presented by the committee and the proposed standard forms cost supporting are shown as follows:

TABLE 1—COST OF CONSTRUCTION, LITTLE VALLEY CATTARAUGUS ROAD, NEW YORK STATE

Name of Road: Little Valley Cattaraugus, Part 1. (Cattaraugus Co.)
Length, 5.85 mi.—3,900 lin. ft., 16′ wide; 9,700 lin. ft., 15′ wide.
Thickness 6″ and 8″=Av. 7″; 5¼″ and 7″ =Av. 6⅛″. (2.575 mi. completed.)
Width, 16′ and 14′ not reinforced. Proportions of mix, 1:1½:3.
Total cu. yds., 8,280. This cost covers 4,165 cu. yds.

Labor, exclusive of water supply, including supervision		$0.423
Plant, forms and tools, 0.662+0.158 for coal		0.820
Expansion joint material		0.045
Water supply, including labor		0.030
Cement	Placed on roadside ready for mixer	1.984
Sand		0.522
Stone		1.505
Total cost per cu. yd		$5.329
Contractor's bid price		6.30

Labor: Rate per hr., 18½ cts.
Teams: Rate per hr., none used.
Hrs. per da. worked, 10.

Remarks: Industrial railway plant delivering sand, stone and cement into hopper of concrete mixer. Clamshell unloader used to take material off cars. Material delivered alongside mixer in buckets proportioned for one-sack batches.

TABLE 2—COST OF CONSTRUCTION, HUNTINGTON-FARMINGDALE ROAD, NEW YORK STATE

Name of Road: Huntington Town Line-Farmingdale, Part 1. (Suffolk Co.)
Length, 1.27 mi.
Thickness, 5″ and 7″=Av. 6″.
Width, 16′, not reinforced.
Proportions of mix, 1:1½:3.
Total cu. yds., 2,051.

Labor, exclusive of water supply, including supervision		$0.56
Plant, forms and tools		0.61
Expansion joint material		0.06
Water supply, including labor		0.12
Cement	Placed on roadside ready for mixer	2.13
Sand		0.22
Stone		1.01
Total per cu. yd		$4.71
Contractor's bid price		5.30

Labor: Rate per da., $1.84.
Teams: Rate per da., $5.00.
Hrs. per da. worked, 9.

Remarks: Auto truck for most of haul. Gravel furnished by large screening and washing plant accounts for high plant cost. Only proportionate part charged for this plant, as it is to be used to produce commercial output.

TABLE 3—COST OF CONSTRUCTION, HUNTINGTON-AMITYVILLE ROAD, NEW YORK STATE

Name of Road: Huntington-Amityville, Part 2. (Suffolk Co.)
Length, 4.69 mi.
Thickness, 4¾″ and 6¾″=Av. 5¾″.
Width, 16′, not reinforced.
Proportions of mix, 1:1½:3.
Total number cu. yds., 7,409.

Labor, exclusive of water supply, including supervision		$0.52
Plant, forms and tools		0.58
Expansion joint material		0.05
Water supply, including labor		0.10
Cement	Placed on roadside ready for mixer	0.23
Sand		0.23
Stone	Gravel	2.36
Total per cu. yd		$4.89
Contractor's bid price		5.30

Labor: Rate per da., $1.84.
Teams: Rate per da., $5.00.
Hrs. per da. worked, 9.

Remarks: Auto truck for most of haul. Gravel furnished by large screening and washing plant accounts for high plant cost. Only proportionate part charged for this plant, as it is to be used to produce commercial output.

TABLE 4—COST OF CONSTRUCTION, FORCE ACCOUNT JOB, ERIE CO., N. Y. STATE

Name of Road: Main St., Sec. 3, Co. Highway, No. 180, Erie Co.
Length, 3.68 mi.
Thickness, average 7″, parabolic crown.
Width, 16′.
Proportions of mix, 1:1½:3.
Total cu. yds., 7,038.

Labor, exclusive of water supply, including supervision			$0.6818
Plant, forms and tools			[illegible]
Expansion joint material	tarred paper	.029	0.2077
	steel plates	.1782	
		.2077	
Water supply, including labor			0.0625
Cement	Placed on roadside ready for mixer		[illegible]
Sand			[illegible]
Stone			[illegible]
Total cost per cu. yd			$5.4867

Labor: Rate per hr., 16½ cts.
Teams: Rate per hr., 50 cts.
Hrs. per da. worked, 10.

Remarks: Work done by state day labor. Materials unloaded by hand. Plant charges included proportionate to life of plant; 7/10 mi. average haul.

TABLE 5—COST OF CONSTRUCTION, NEW HAVEN-SOUTHINGTON ROAD, CONNECTICUT

Name of Road: New Haven to Southington, Connecticut.
Length, 14,100′.
Thickness, 6″ to 8″.
Width, 16′.
Proportions of mix, 1:2:4.
Total cu. yds., 5,107.

Labor, exclusive of water supply, including supervision		$0.494
Plant, forms and tools		0.254
Expansion joint material		0.030
Water supply, including labor		0.203
Cement	Placed on roadside ready for mixer	1.764
Sand		0.533
Stone		1.37
Reinforcement		0.29
Total cost per cu. yd		$4.94

Labor: Rate per da., 50 cts.
Teams: Rate per da., $5.00.
Supt., $4.00 per da.
Asst. Supt., $3.50 per da.
Hrs. per da. worked: 8 hrs. for labor, 9 hrs. for teams.

Remarks: Boom mixer used. Local sand was screened and washed. Stone was crushed trap delivered to mixer by trolley. Cement was delivered by the steam road to the trolley and by the trolley to the mixer. Labor was done by inmates of the State Reformatory, which accounts for the very low labor rate. Reinforcement consisted of galvanized triangular mesh.

In concluding its report the committee considered whether or not cost data available indicated any direction in which future economy might be effected. After a discussion by the members of the committee it was decided that any attempt to reduce the cost of concrete materially except in instances where organization of crews was grossly inefficient or modern types of plants had not been used to the best advantage, would result in corresponding reduction in quality. In this connection the committee states further:

> There is little chance for any considerable saving in putting the materials into the drum at the mixer, or in taking the mixed concrete from the machine to place. Any savings that might be made in these instances would very likely be at the expense of quality. Reducing the

TABLE 6—CONCRETE ROAD COSTS REPORTED BY ASSN. OF AM. PORTLAND CEMENT MFRS.

State	Name of Town or Road	Sq. Yds.	Labor	Teaming	Mechanical Equipment	Material	Misc.	Total Cost per Sq. Yd.
Fla.	Port Tampa City	1,882	.105	.044	.004	.878	.016	1.047
Ill.	Belleville (Av. for 2 wks.)		.153	.050		.9972	.001	1.2012
"	DeKalb	3,642	.2773	.1009	.033	.5284	.0162	.9558
"	Morrison	6,500	.1203			.8993	.0043	1.024
"	Moline	2,889	.1333	.243		.5533	.005	.9346
Ind.	Anderson and Middletown	2,316	.1125	*	.0309	.7336		.8771
"	Woods Henderson	638	.1072	.144	.0040	.880		1.135
"	Seymour	4,110	.080	.160	.0010	.696	.005	.942
Iowa	Bloomfield	641	.247	.044	.008	.908	.008	1.215
"	Indianola	9,716	.1595	.0353	.0141	.829	.0015	1.0394
"	Cedar Rapids	2,027	.1871	.111	.033	.869	.042	1.2421
"	Eagle Grove	3,033	.171	.122	.009	.954	.009	1.265
"	Nevada	2,047	.1893	.0517	.021	.860		1.122
"	Clarinda	1,399	.274	.057	.065	.834	.046	1.276
Kan.	Bassett	7,310	.3499		.0278	.910	.006	1.2837
Ky.	Bardstown Rd	1,180	.180	.214	.020	.476	.029	.919
Md.	District Line, Seat Pleasant	1,219	.136	.138	.076	.809	.633	1.192
"	Fredericktown	2,453	.103	.141	.050	.692	.049	1.035
"	Galena-Georgetown	1,504	.102	.108	.069	.675	.069	1.023
Mass.	Northridge	360	.218	.098	.046	.653		1.015
"	North Andover	420	.177	.1307	.030	.663		1.00
"	Taunton	360	.191	.084	.041	.510		.826
Mich.	Kawkawlin Rd.	1,347	.168	.006	.016	.699	.016	.906
"	Flint, N. Saginaw St.	1,056	.459	.047		.760	.037	1.303
Minn.	Minneapolis	3,448	.130	.1304	.2999	.5505		1.1108
Miss.	Tupelo	1,504	.102	.108	.069	.675	.069	1.023
Mo.	Boonville	388	.084	.086	.0025	.563	.003	.7385
"	St. Louis	7,620	.2868	.0451		.903	.0295	1.2644
"	St. Louis, Gravois Rd.	5,278	.256		.2571	.740	.0075	1.2606
N. H.	Nassau, Bridge St.	575	.1258	.0912	.0323	.907		1.1563
N. J.	Red Bank, Mechanics St.	1,172	.244	.090	.013	1.108		1.455
"	Union Co., Linden Twp.	2,611	.122	.080	.029	.805		1.036
Ohio	Rockport	1,283	.162	.092	.151	.648		1.053
"	Madison Twp. Road	986	.250	.225	.055	.456	.011	.997
"	Addy Pike	1,657	.091		.067	.882		1.040
"	Ironton, Law Alley	498	.209	.049	.060	.652		.970
Penn.	Nicholson Borough	1,942	.300	.078	.033	.715		1.081
"	Nazareth, Main St.	484	.222	.029	.012	.623	.055	.941
Texas	Robinson Rd.	2,026	.446	.220	.010	.454	.024	1.154
W. Va.	West Union		.098		.074	.853		1.025
Wis.	Racine	4,015	.1665	.088	.1059	.829	.012	1.2014
"	Eau Claire	2,031	.2168	.0474	.0224	.5611	.0186	.8663
"	Superior	1,520	.1602		.0005	.8256		.9863
Canada	Ont., St. Thomas, York St.	172	.2714	.1124	.0952	.8127	.0206	1.3123
"	Stratford, Paterson Ave.	189	.1735	.0563	.0460	.8611	.0079	1.1448
"	Chatham	399	.1276	.0427	.032	1.0317	.002	1.2360
"	Jarvis	296	.2121	.1076	.010	.713	.013	1.0557
"	Ont., Jarvis	347	.147	.068	.013	.851		1.079
"	St. Thomas	186	.1870	.114	.0396	.7745	.001	1.1161

*Teaming in Material column

TABLE 7—AVERAGE COST PER SQ. YD. OF CONSTRUCTING CONCRETE ROADS, REPORTED TO THE ASSN. OF AM. PORTLAND CEMENT MFRS., 1913 AND 1915

Figures for 1915 gathered by Assn.'s Inspectors

	1913	1915
Connecticut	$1.32	$1.13
Illinois	1.01	1.03
Indiana	1.23	0.98
Iowa	1.11	1.19
Kansas	1.08	1.28
Maryland	1.21	1.08
Massachusetts	1.29	0.95
Michigan	1.27	1.10
Minnesota	1.05	1.11
Missouri	1.17	1.09
New Jersey	1.12	1.23
New York	...	0.98
Ohio	1.22	1.02
Pennsylvania	1.16	1.01
Texas	...	1.15
West Virginia	1.32	1.03
Wisconsin	1.06	1.02

PROPOSED STANDARD FORM FOR COST REPORTING

Name and Location of Road................
Length....... Width....... Thickness.......
Proportions of Mix......No. of Cu. Yds.....

Per Cu. Yd.

1*. Labor:
On sub-grade ....$ ....
On forms ....
Material to mixer....... ....
Mixer to place.. ....
Covering and cleaning... ....
Total labor ....$ ....
2. Concrete Materials:
Cement, f. o. b.......... ....
Hauling ....
Storage ....
Loss sacks and waste.. ....
Sand, f. o. b............ ....
Unloading ....
Hauling ....
Stone, f. o. b. or in bins ....
Unloading ....
Hauling ....
Total concrete materials.....$ ....
3. Water:
Charge for ....$ ....
Piping ....
Pump ....
Labor, etc. ....
Total water .... $ ....
5. Plant and Forms (interest and depreciation) ....
6. Reinforcement .. ..
7. Joints ....

Total cost concrete pavement..$ ....

WAGE SCALE

Superintendent ....
Assistant Superintendent ....
Skilled labor ....
Common labor ....
Teams ....
Auto trucks ....
Length of working day......................
(Remarks on features of plant and materials which have special bearing on costs.)
*Includes supervision

time that the materials are left in the drum is clearly undesirable.

Again, in the cost of mineral aggregate, economy is very likely to be at the expense of quality. Likewise in the matter of cement: lower costs, attained either by reducing the quantity of cement or accepting a poorer quality are manifestly not to be tolerated.

There is, however, a possibility of economies in the general operation of the work. Such economies can be effected, first, by a proper arrangement of a sufficient amount of material shall at all times be available so the work may be carried on continuously. Your committee insists that no reduction in cost should be permitted which will in any way injure the final pavement.

While it is not in the province of this committee to indicate the quality of material or the character of the final structure, it would seem well to take advantage of the opportunity to assert that every possible refinement should be made, not only in the selection of materials for concrete but in the method and manner of manipulation, so that the final mixture will be as nearly perfect as possible. A concrete pavement is subject to the most severe service stresses known to a concrete structure. Emphasis upon excellence of material and quality of workmanship is therefore imperative.

Committee 17—Estimating and Inspection Problems

CHAIRMAN, A. MARSTON;[1] JOHN H. MULLEN,[2] K. H. TALBOT,[3] H. A. JOHNSON.[4]

In considering Estimating and Inspection Problems the committee called attention to problems and conditions which enter into road construction materially affecting the cost and frequently not considered or at least not considered in sufficient detail to make possible a close analysis of the cost of the work. In introducing the subject the committee says that experience has shown that in the past some contractors have merely examined the estimate of the engineer and then have bid as low on the job as they thought necessary in order to secure the contract. Frequently this has been done without any analysis on their part as to the cost of the work. It was pointed out by the committee that this class of bidders are now coming to realize that with keener competition and the larger mileage that is being put under contract in each job, a detailed analysis of cost is absolutely necessary for intelligent bidding. Some estimators make a practice of driving over the road in question but the more careful walk over it, noting the various physical characteristics that will in any way affect the cost of the construction. This is a more advisable practice. The committee says that an examination may reveal a wet spot here, a spring there; a good location for an unloader, a site for a sidetrack; the location of a creek or a water hole in which a pump can be installed and such other peculiarities of the particular job as may materially affect the ultimate cost. In an investigation of this nature there are a number of elements which affect the cost, and also the speed with which the work can be accomplished.

The committee calls attention as one of the preliminary things to be considered in the construction of the road, the extent of the traffic which is using the road and which must be re-routed. Peculiar conditions frequently enter into this consideration; for example, a road adjacent to a fair ground may entail considerable expense in order to make provision for traffic such as will occur when the fair is in progress. A detour through an adjacent field which would be entirely adequate for all ordinary hauling will prove entirely inadequate where there is large motor traffic. The season of the year will also affect the cost of caring for traffic and it may prove important to obtain from residents on the road some idea of the condition of the road at various seasons so as to learn the best time for undertaking construction with the least inconvenience to the traffic ordinarily using the road.

The cost of hauling materials is also considered by the committee and is a very important item, with many factors to be considered. Inability of railways to get material delivered when needed may prove sufficiently important to warrant the contractor in maintaining a fairly large stock of material in reserve. The relative cost of hauling material direct from cars as compared with that of maintaining stock piles is to be considered. The cost of transportation from the terminal to the site of the work must be taken up in detail and in this must be considered the amount of new sub-grade over which the materials must be hauled, inasmuch as over such a roadway the cost of hauling will be much higher than over an established road bed. In view of the fact that other committees took up in detail the matter of hauling problems, this committee merely called special attention to the necessity of a careful analysis of the situation in each case to determine what method of hauling is best suited to the peculiar requirements of the job. The committee points out in this connection that certain materials such as rolls of mesh reinforcing will be hauled in loads which are limited by bulk rather than by weight. In handling materials at the site not only the local conditions but the particular specifications are to be considered, as there is great difference in cost between handling materials from the sub-grade and handling them from stock piles or on platforms; and the number of piles will materially influence the result. The estimator must carefully determine the probable need of under drains and their cost and this requires a knowledge of the character of the material through which the drains are to pass.

The cost of preparing and finishing the sub-grade will be affected by a number of items, including the relative amount of excavation and embankment, the length of haul required to make the embankment either by using excavated material or a material obtained from borrow-pits, the availability of borrow at a reasonable price and many other local conditions. Consideration must be given to such matters as cleaning out ditches, finishing slope, shoulders, etc. The cost of finishing the sub-grade will depend altogether upon the character of the sub-grade and the material which composes it. If the sub-grade is particularly dry in the month of the year when construction is being carried on the item of water will be a considerable one.

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[3] Division Engr., Universal Portland Cement Co., Pittsburgh

[4] Contr., Kalamazoo, Mich.

In connection with cost of materials, the estimate for the cement, for instance, will include not only the net cost of the cement but the cost of hauling and returning the sacks. The cost of protecting the cement and storing it on the job must be considered and in this connection consideration will be given to the fact that the number of storage sheds required will vary with the methods of transporting the cement. In connection with the cost of aggregates attention will be given to the fact that this cost will vary with loss due to handling. This loss will be dependent upon the length of haul, character of road and methods in handling and will vary from 5% to 10%.

The cost of placing materials embraces three items: interest and depreciation on equipment, the amount and the character of the labor, and the unit cost of the labor. All these of course are influenced by the definite methods produced. The amount of labor required will depend upon the methods adopted in placing and handling the materials and the men. The availability of labor in the community must be considered, legal restrictions, such as minimum wage and maximum hour laws, state insurance and compensation laws, together with local ordinances which will vitally affect the labor market. Another thing to be considered is the location of the improvement with reference to boarding and housing facilities for the men. If the men cannot be placed for board and lodging at farm houses in the vicinity it becomes necessary to consider the cost of labor camps and the cost of labor camps is frequently affected by state restrictions affecting sanitation, etc., which may materially increase the cost of maintaining the camps. The contractor should also consider the cost of carrying securities. Sometimes counties have difficulties in disposing of their bonds and contractors are paid in warrants which bear interest at the rate of 6% but which banks sometimes will not cash except at a 5% or a 10% discount.

In connection with inspection problems, the committee says that good construction of course lies first with the engineer in charge and that the engineer who carefully plans the detail of construction will have little difficulty with the better class of contractors. The first step in securing satisfactory construction is the drafting of a set of specifications which adequately cover each operation incident to the performance of the work. The specifications should be definite in each operation entailed in the construction and each class of materials used should be definitely specified. The committee urges the most definite language in the specifications.

In connection with the inspection force, the character of the inspection materially affects the quality of the resulting product and undoubtedly there is no other official connected with the work who should be more carefully chosen. This committee points out that the inspector should be a man of absolute integrity and of pleasing address, such as to inspire confidence not only in the contractor's organization but among the taxpayers living in the vicinity of the work. He must be a man of forceful personality and of quick judgment and thoroughly experienced in the details of the construction. The committee recommends that a manual of construction be furnished to all members of the inspection force. This will be distinctly worth while in any organization handling a considerable amount of concrete pavement construction.

The building industry in England is suffering very much on account of the war. No one seems ready to build and outside of munition factories and additions to existing works little or no new construction is going on. Labor is short and the transportation of materials is difficult. Many of the large contracting firms have gone into the munitions business themselves and are busy with government orders. "One thing is of interest," says *Concrete and Constructional Engineering*, "and that is to remember that certain materials can be obtained more easily than others and it is necessary to make a judicious selection to avoid delay in carrying out work owing to one of the essential elements in construction not being available."

It is here that reinforced concrete will be found of advantage as compared with ordinary constructional steel, and the war has done much to show up the possibilities of the former material. There appears to be little or no difficulty in obtaining ordinary round bars for reinforcement, and these are easily transported, while rolled steel sections are difficult to obtain, and built-up members involve work in the shops which takes time and diverts labor which might be more profitably employed in the manufacture of shells and machines of war. Under proper supervision the labor required for reinforced concrete work is practically unskilled, and its employment on the building of war factories is an example of the proper application of our resources, as such men could be of little use to the country in any other sphere apart from the army itself. There are also other points to be considered in dealing with a comparison of steel and reinforced concrete, and one of these is the question of economy. Owing to certain stock steel sections not being available at the present time the designer is compelled to adopt the next largest size that can be obtained, and, in consequence, more steel is employed than is theoretically necessary. This does not hold with reinforced concrete, as the designer can vary the number of bars used, and the fact that any particular diameter bar is not at hand will simply mean less larger bars or more smaller bars, each providing the requisite area of steel and no more.

16,401,346 Yds. of Concrete Paving in 1915

Concrete paving in 1915 is tabulated by the Portland Cement Assn. as follows:

	1915			
	CONCRETE PAVEMENTS			
State	Streets	Roads	Alleys	Totals
Ala.	8,372	2,888	......	11,260
Ariz. ..	......	......	......	......
Ark. ..	212,647	......	6,600	219,247
Cal.	333,114	3,595,406	......	3,928,520
Col.	23,450	......	40,000	63,450
Conn. ..	121,020	96,783	......	217,803
Del.	......	66,000	......	66,000
D. C. ...	36,775	1,990	......	38,765
Fla.	14,070	......	......	14,070
Ga. ...	105,041	......	......	105,041
Idaho ..	5,067	4,280	......	9,347
Ill.	200,594	589,685	149,296	939,675
Ind.	294,389	427,077	2,599	724,065
Iowa . .	749,459	20,648	61,572	831,679
Kans. ...	192,238	18,942	23,321	234,501
Ky.	1,300	21,186	478	22,964
La.	......	3,100	......	3,100
Maine ...	4,480	74,172	......	78,652
Md.	102,403	495,298	36,600	634,301
Mass. ...	75,470	138,660	261	214,391
Mich.	159,482	607,209	128,568	895,259
Minn. ...	198,709	73,944	15,912	288,565
Miss.	21,128	70,200	......	91,328
Mo.	437,133	622	15,037	452,792
Mont. ...	9,390	......	......	9,390
Neb.	125,882	18,777	939	145,598
Nev.	16,480	......	......	16,480
N. H. ...	......	......	......	......
N. J.	80,904	50,726	615	132,245
N. Mex. .	9,432	......	......	9,432
N. Y. ...	209,192	1,156,553	5,074	1,370,819
N. C. ...	32,684	14,092	......	46,776
N. D. ...	29,173	......	......	29,173
Ohio	259,175	1,310,243	42,830	1,612,248
Okla.	51,250	......	......	51,250
Ore.	35,091	115,762	......	150,853
Penn. ...	37,727	65,149	10,577	113,453
R. I.	......	......	......	......
S. C.	......	......	......	......
S. D.	57,486	......	4,623	62,109
Tenn. ...	72,062	26,000	......	98,062
Texas ...	375,459	138,509	1,973	515,941
Utah	76,041	39,424	1,875	117,340
Vt.	......	......	......	......
Va.	29,289	......	983	30,272
Wn.	174,098	221,493	4,087	399,678
W. Va..	34,412	140,746	7,009	182,167
Wis.	831,004	372,672	17,692	1,224,368
Wyo. ...	1,917	......	......	1,917
Totals..	5,844,589	9,978,236	578,521	16,401,346

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

The Use of Hydrated Lime in Dry-Tamp Mixtures of Concrete

THE FOLLOWING QUESTION IS DISCUSSED BY:

NORMAN G. HOUGH[1]
E. L. CONWELL[2]
H. B. H. HURD[3]

"I should like to know something about the experience of the field in the use of hydrated lime in mixtures of concrete which have to be dry enough to be manipulated in a block machine of the dry-tamp type, from which the product is removed immediately after being molded. Will the value of hydrated lime, as a waterproofing, be secured with the minimum of water which has to be used in order to handle such a mixture, or will the addition of the hydrated lime to the mixture make it possible to use more water (due to the hydrated lime's affinity for water), which will become available later on in the hydration of the cement? In general, I should like all the information there is available as to the value of hydrated lime in such mixtures of concrete."

BY MR. HOUGH.

The strength of a concrete block is determined by three prime factors: First, the amount of cement which is used in the mixture; second, the uniform distribution of the cement; third, the amount of cement which hydrates after the block has taken its form.

The latter factor is the chemical reaction which takes place upon mixing cement and water together. It will therefore be recognized that the quantity of water with which the cement can react has perhaps far greater value in determining strength than the two factors first mentioned.

It is an established fact and has recently been conclusively proven by an investigating committee that an addition of hydrated lime to concrete without increasing the quantity of water in a mixture makes a mix of thicker consistency. The capacity of hydrated lime for absorbing and carrying water is about three times greater than that of cement; consequently an addition of 10 lbs. of hydrated lime will carry into a concrete mixture approximately as much water as 30 lbs. of cement and it does this without changing the consistency of the mixture.

Since it has been indicated that the quantity of water used has so much to do with subsequent development of strength, and since it has also been shown that hydrated lime carries considerably more water into the mixture with about the same consistency, it is evident that this additional quantity of water should be taken up by the cement in the process of increased hydration, thus having a value in producing greater strength in a cement product made with a dry-tamp mixture.

The value of hydrated lime as a watertightening medium will not be lost due to the minimum amount of water used in a dry-tamp mixture. Hydrated lime, as a watertightening medium, acts in two ways: First, it is a more finely divided material than cement and serves to fill the voids; second, it increases the workability of the concrete so that the greatest possible density can be obtained in tamping. The more dense a cement product may be, just so much greater is the possibility of its being able to resist the passage of water.

Block manufacturers who are using hydrated lime claim that their products leave the forms very clearly and dry out uniformly light in color.

In view of the possibility of an increase in strength, a dense watertight product and a uniformly light color, the incorporation of hydrated lime in concrete products is warranted.

BY MR. CONWELL.

With respect to the use of hydrated lime in dry-tamped mixtures of concrete, I would state first that the greater plasticity of the mixture containing hydrated lime will enable it to be cast more perfectly. That is, the concrete containing hydrated lime will better conform to the molds, which result should, in my opinion, be attained with less labor and care in tamping.

As to the amount of gauging water to be used, I feel that the addition of hydrated lime will necessitate the use of slightly more gauging water, since hydrated lime requires more gauging water than an equal quantity of Portland cement. I do not believe, however, that it will be possible to use a notably greater quantity of water than with a straight Portland cement mixture, particularly if the product is removed from the molds immediately after casting, for under those circumstances, the presence of even a slight excess of gauging water would lead to breakage of many of the block.

Referring to the disposition of the water taken up by hydrated lime, it is, of course, true that a portion of this water is eventually taken in combination by the cement and assists toward the setting and hardening of the cement. This water is, of course, available for combination with the cement during its later hardening stages, when in straight Portland cement concrete little, if any, additional water is available and it is not illogical to expect an improvement in the strength of the block from this circumstance.

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[2] Vice-Pres., Henry S. Spackman Engrg. Co., Phiadelphia

[3] Pres., New England Stone Co., New Haven, Conn.

It should be kept in mind by anyone using hydrated lime in this way that the more plastic the hydrated lime used, the greater benefit will be conferred by it on a concrete mixture. Extremely thorough incorporation of the hydrated lime with the mixture is also vital to success in its use. It should be also realized that in spite of the benefits accruing from the use of hydrated lime, it will not and should not be expected to overcome the use of improperly proportioned aggregates of aggregates of inferior quality.

By Mr. Hurd.

With reference to the use of hydrated lime in dry-tamp mixtures of concrete, we have no difficulty in block work from the use of hydrated lime. We use 15% of hydrated lime to the amount of cement (by volume) and the average amount of water used in the manufacture of our block is 20% (by weight of the cement.) Tamping, if properly done, should take care of any surplus water, and no difficulty should be experienced in handling the block taken immediately from the ordinary block machine. Possibly, in some instances, the plates might stick a little, but if properly cleaned, there should be no serious trouble.

Cracking and Discoloration in Sand-Finished Stucco Surfaces

The Following Questions Are
Discussed By:

Wm. M. Kinney[1]
W. A. Davis[2]
E. K. Borchard[3]
J. M. Gibson[4]
F. O. White[5]
L. C. Wason[6]

"How can I put on a sand-finish stucco that will not crack and that will hold a uniform color? Of what value is the use of short-fibre asbestos in correcting this condition? Can a coating in the nature of a lime-cement wash be applied that will give satisfactory results?"

By Mr. Kinney

Checking and cracking of a sand-finished stucco surface can be minimized by careful attention to details but discoloration is a matter which it is harder to overcome. It is a far more difficult matter to prevent discoloration on sand-finished surfaces than on surfaces which are given a rough-cast finish. The latter can be applied rapidly enough to complete the whole side of a house in a day's time and when once applied, needs no further manipulation. A sand finish, on the other hand, requires more time and smaller areas must be gone over in obtaining the proper texture, so that the chance for discoloration is greatly increased. Although much depends upon the use of a properly proportioned mixture, the result is largely a matter of manipulation. A great deal depends upon the skill and thoroughness displayed by the workmen. The manner in which the workmen trowel the surface will influence the color. Sometimes different shades may be seen similar to those noticeable on the surface of a newly completed sidewalk, half of which has been finished from one side and half from the other.

Overworking and overtroweling of a sand finish will bring too much of the fine material to the surface and, as in the case of sidewalks and floors, will cause trouble through checking and cracking. Over-richness of mixture is another cause of troube and we believe that for a sand-finished stucco surface, the finish coat should generally be mixed in proportions of 1 sack of cement to 2½ of fine aggregate.

One experienced plasterer has suggested that when the finish has been applied, floated and troweled, the workman go over the surface after the finish has begun to harden, using a float covered with soft carpet or felt, in order to even up the appearance of the wall both as to texture and color. In this way he believes surface checking can be overcome, and the chance of discoloration greatly lessened.

Hot sun or winds produce rapid drying of stucco surfaces, which results in checking to a considerable extent; under such conditions the surface should be protected by hanging wet blankets in front of the wall and keeping them wet for several days, or by spraying the wall with water frequently after it has hardened sufficiently to prevent injury.

By Mr. Davis

This is a finish we are rarely called upon to use, but from what we can learn the cracking in such work is generally caused by shrinkage due to the base being put on lumber not thoroughly seasoned. If the trouble is not from the base it is evident that either the finish or the application is at fault. The finish should be mixed in the proportion of 1 part cement to 2 parts of very sharp sand which has been thoroughly washed. To form perfect adhesion this should be applied on a base which is very wet.

We have had no experience with short-fibre asbestos, but our judgment would be that it would not stop the cracking.

A uniform color can be obtained by a lime-cement wash, provided the lime is allowed to stand until the heat is worked out, otherwise it will air-slack after application and flour off.

By Mr. Borchard

The best method of obtaining a sand finish for stucco work is to float the surface with a wooden float covered with burlap. This finish may also be obtained by using a wooden float made of rough, unfinished board. Where finishes of this kind crack and the cause is not due to an insecure base, it is probable that the cracking is due to the stucco not being properly cured. It is very essential that stucco does not dry too quickly. If the surface is exposed to the sun it should be covered with a wet canvas or sprinkled frequently.

It is our opinion that short-fibre asbestos would not assist in preventing cracking in stucco work. We would not advocate the use of a lime-cement wash, owing to the fact that there is danger of its cracking and peeling off in the course of time.

By Mr. Gibson

Outside stucco should never finish less than 1″ thick. That allows ⅜″

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[2] The Youngstown Sheet & Tube Co., Youngstown, Ohio

[3] Infor. Bur., Portland Cement Assn., Chicago

[4] Asst. Engr., Struct. Products Dept., Clinton Wire Cloth Co., Clinton, Mass.

[5] F. O. White Const. Co., Cambridge, Mass.

[6] Pres. and Mgr., Aberthaw Const. Co., Boston

for a scratch coat, 3/8″ for a brown coat and 1/4″ for the finish coat.

The utmost care should be exercised in selecting the sand for stucco; it must be absolutely free from loam or any organic matter. Not only will dirty sand prevent the proper curing of cement, but it will discolor the fresh coat. Sand used in stuccoing should be clean, coarse and angular, the cement of the best brands obtainable, and if lime putty is used it should be well seasoned and not to exceed 10%. The best hair binder or fibre should be used in the scratch coat, but it is not necessary in the brown coat. Before applying one coat on another the preceding coat should be scarified, scratched and thoroughly dampened so as to prevent the absorption of water from the new coating.

In applying the finish coat, to obtain what is known as a sand finish, a slight excess of sand is used in the mixture, and the plaster is not allowed to get very wet. The sand should be large-grained and coarse.

It is not well to trowel the external coat too much, as it is apt to cause the plaster to crack and scale off. All cement surfaces will ultimately develop incipient cracking or hair-cracks. In a rough-sand finish these cracks do not show except on close examination.

If the above specifications are followed, good workmanship is used and absolutely the best of materials, with a special emphasis on clean, coarse sand, there should be no trouble in obtaining a stucco exterior which will become more beautiful as Time goes on.

By Mr. Wason

The value of the use of short fibrous asbestos is similar to that of using cattle hair or cocoanut fibre to give density to the mortar in its first coat so that it will cling to the lath. I do not believe that a coating of the nature of lime-cement wash can be applied to give satisfactory results. It is too thin and will crack and peel. I should expect that the trouble was due to porosity of the stucco as a whole. Rain drives into it and some returns to the surface, bringing with it soluble salts which are deposited, giving discoloration. The remedy is to waterproof the exterior surfaces.

Cracking is caused by the frame of the building not being sufficiently braced to be rigid and perhaps built with such green lumber that its shrinkage will cause cracking, or by insufficient lapping of sheets of lath and tying of them together. On very large surfaces, the natural shrinkage of the material is sufficient to cause cracking independent of the above causes.

By Mr. White

Sand finish that will not crack has to be put on in two coats or three coats, the first coat allowed to dry and shrink all that it will before the second coat is put on; the second coat should not be too fat with cement, not more than a 2:1 mixture.

The last coat should not be allowed to dry out too quickly; the more time it takes in drying, the better will be the work.

I do not know anything about short fibre. I should think it would be a good material if used in the right manner; this one would get from short experience in using the material.

Lime-cement wash is of little value except to make the work look better for a short time, as a ceiling will look after it is whitewashed. It does fill up any cracks in the surface of the work. This is of some help. Work properly done will not need any of this treatment.

There are on the market several good cement paints that are good for this treatment, that will last for a long time and that will leave a good even color.

To get a good, natural, even surface, I should select my sand for purity, mix in a clean box, using a clean water, and put on a lath that was not rusted. If rusted, be sure that the first coat is dried uot before the second coat is put on. I should use white sand if I could get it.

Depreciation of Concrete Buildings □

THE FOLLOWING QUESTION IS DISCUSSED BY:

J. H. P. PERRY[1]
LEONARD C. WASON[2]

What rate of depreciation should be charged against reinforced concrete industrial buildings?

By Mr. Perry

This is a most interesting question, on which I have never seen any authoritative discussion. Personally, I have generally felt that 1/4 of 1% per annum is sufficient depreciation to charge against concrete buildings aside from the commercial value factor which varies in every locality and every usage. Most of the authorities allow 1½% per annum depreciation on first class mill construction buildings and certainly with concrete factories and warehouses, 1/4 of 1% should be enough, inasmuch as the only foreseeable depreciation will be largely in roofing, doors and windows; the structure itself is as permanent as anything we know of.

The Pacific Coast Borax Co. building, the first commercial concrete building erected in the East at least, was built in '97 and '98 and is today in good condition. The Robert Gair Co. factory—the first really large industrial plant built—was constructed in 1904 and so far as we can see today is as good as ever, with the exception of a slight wear on the floor. These are the oldest records which our company has any direct acquaintance with. We do not know what rate of depreciation the owners carry on their books in connection with these two buildings.

I would like very much to see further discussion of this subject.

By Mr. Wason

This is a subject with which I am not very familiar. I cannot give you any figures, but discussions which I recall by others who have investigated have always set the percentage of depreciation a little lower than that of any other type of construction.

The effect of concrete roads on horseshoes has recently been discussed by the resident engr. of the Southeastern Division of the Maryland State Highway Comm. The issue rose through statements of the farmers that concrete roads necessitate more frequent renewal of horseshoes than surface-treated macadam roads. In the district referred to, observation has been made of the effect of each class of road upon horseshoes. From actual examination, W. F. Childs, the engineer in question, reports that while horseshoes do wear more rapidly on concrete, they last longer. This is explained by the fact that on concrete roads the entire shoe not only wears evenly throughout, but will maintain its hold until very thin, whereas on macadam roads uneven and half-worn shoes indicate that they have been twisted off by the rough surface.

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Correspondence: A Department in Which the *Reader* Becomes the *Writer* □

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow." □ □ □

Should More Than One Mixture Be Used on Buildings? □ □

—A Letter From A. M. Wolf[1]

In my estimation it would be of interest to learn what contractors and engineers in general think of the practice of using several different mixtures of concrete in different portions of a structure.

My observation has been that the usual reason for the employment of different grades of concrete is one of economy or a desire to effect a certain architectural treatment of the surface.

Let us consider at the outset the question of economy. From the standpoint of the designer it is legitimate to specify a lean mixture wherever the concrete is in mass and not subjected to very great compressive stresses, and a richer mixture where all possible compressive strength is desired, as in heavily reinforced work. Viewed from the standpoint of the contractor, the use of many mixes may not in all cases be economical, since much additional labor may be entailed in building forms so as to allow the proper placing of the mixtures specified, and also in the actual pouring of the concrete.

In heavy foundation work of plain concrete, such as bridge pier footings and column footings in buildings, where a 1:3:5 mixture is often used, a real economy is no doubt effected, since the placing of these portions of the structures is always a separate operation as related to the rest of the structure. However, where the conditions of design are such as to require the employment of more than one grade of concrete in parts of the structure which should or must be constructed simultaneously, it may be more satisfactory and economical to use the richer mixture throughout rather than cause delays and disarrangement of the labor organization by switching from one mixture to the other at relatively short intervals. Then again under such conditions some errors in placing are bound to occur unless the inspection is constant and vigilant. The tendency in such cases is almost without exception, if any mistake is made, to place the weaker mixture where the richer concrete is required for structural reasons, and vice versa. The placement of the wrong grade of concrete in important members of a structure may lead to overstressing of the concrete or even to failure, and for this reason varying the quality may not be good practice.

In ordinary concrete work the cost of the cement is only a relatively small portion of the entire cost and a slight change in the amount of cement used in various portions will effect no material saving, all other things being considered.

It is general practice, especially in large concrete buildings, to use a richer mixture (1:2:4) in order to keep the column sizes as small as possible by taking advantage of the additional load-carrying capacity of the richer mixture. This is permissible and economical practice, but demands the most careful inspection to insure the richer mix being placed in all columns. No doubt in many buildings where the inspection was lax the concrete in columns is no different from that in the floors, even though a better grade was specified in the former.

Where architectural treatment is the main consideration the use of different mixtures involving a change in the amount of cement and also the class of aggregate for the placing may be a necessity in order to permit the proper surface finish. If this mixture is placed as a thin layer at the same time as the backing, the cost of the concrete is greatly increased because of the difficulties attendant with placing. If the exposed surface area is great as compared with the total yardage of concrete in the part in question, economy may be effected by using the facing mixture (or slightly modified) throughout.

As a general rule, in the writer's estimation, contractors are inclined, and justly so, to add considerable for contingencies on jobs where many different grades of concrete are to be employed and instead of resulting economically for the owner such a specification is really detrimental to his interests and the engineer will do well to reduce the number of classes of concrete to an absolute minimum by confining the changes in mix to such parts as are not built simultaneously.

According to the Little Rock, Ark., *Gazette,* the State penitentiary in that state has made improvements this year for a sum of less than $100 which "at first sight would have appeared to have cost several thousand dollars." The floors of all buildings and stables have been concreted, and many other improvements in connection with sanitary improvements have been made and the value of the property greatly increased. Here is the meat of the whole matter, the *Gazette* says: "And it shows how the cost has been paid out of what was regarded as waste in the past." To pay for the cement used in the penitentiary the commission traded sacks that had accumulated. "Each sack is worth 10 cts. and by collecting hundreds of these on the state farm and around the walls the officials were able to pay for practically all the cement used in the work." This little experience teaches a practical lesson in what can be done in many places by simply caring for sacks and utilizing them. The sacks were returnable in the first place but careless management and careless accounting paid the cement makers in full without taking deductions for sacks.

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[1] Prin. Asst. Engr., The Condron Co., Chicago

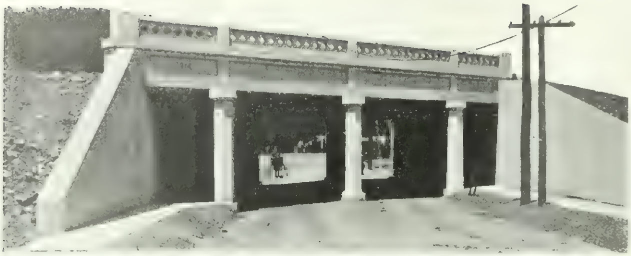


Fig. 1—General View of Bridge Over Highway at Hallstead, Pa.

A Reinforced Concrete Slab Railroad Bridge With Skeleton Piers and Cantilever Abutments

By Albert M. Wolf, C. E.

The Church St. overhead bridge of the D. L. & W. R. R. at Hallstead, Pa., is one of the small but interesting structures built by this road on its relocated line between Hallstead and Clark's Summit, in connection with which the Martin's Creek and the Tunkhannock Creek viaduct were built. This bridge crosses Church St., which is 50′ wide, at a 50° 21′ skew, carries four tracks on the spiraled end of a 2° curve and has an underclearance of 14′. The concrete slab deck, composed of two roadway spans, 16′ 6″ o. c., and two sidewalk spans 9′ 6″ o. c., is carried on three lines of skeleton piers and abutments cantilevered out from the curb line piers (Fig. 2).

These abutments are the unique part of the design, their use having been decided upon because the street, being on a 8-ft. fill, necessitated an excavation of about 14′ to find suitable material on which to place the footings. To use gravity abutments would have meant the use of a large amount of concrete which, coupled with the excavation necessary therefor, would have been very costly. Accordingly the curb pier footings were combined with cantilever shaped footings perpendicular to them at 15-ft. centers which carried counterforts for the vertical slab 14′ 6″ high, which forms the abutment face to retain the fill; the sidewalk slab connects the stem of T's which at their outer ends carry the counterforts. The abutment slab was designed as a horizontal beam for a moment of WL/10 between counterforts for both positive and negative moment and the same amount of steel used in both faces in the form of straight bars. Vertical reinforcement was used in both faces to distribute loads and care for temperature stresses. The cantilever footing T-beams are 5′ wide and extend 13′ 3″ beyond the line of curb pier footings so as to distribute the load uniformly over the area at a pressure of 3 tons per sq. ft., which was deemed the maximum allowable for the soil encountered.

The abutment wing walls are designed as counterfort retaining walls with the face slab carried down just below sidewalk level, except for one wing, which is flared at 73.5°, where this slab is carried down to the footing.

The piers are of skeleton construction consisting of six reinforced concrete columns 15′ o. c. resting on a continuous slab footing 5′ wide for center pier and 4′ 6″ for curb pier, and 2′ 6″ thick. They are connected at the top by a girder 3′ 9″ thick with elliptical arched connections. This girder is designed for the same moment as if it were simply supported with half the bars in each span bent up at each end to give the same area of steel in the top over columns as in the bottom at mid-span. The columns rest on enlarged plinths extending from the footings to 1′ above grade. The intermediate columns are 2′ thick at right angles to street and 3′ 4″ in the other dimension, while the end columns have a 45° nosing projecting 8″ to add to the architectural appearance.

The deck slab, 2′ 3″ thick over the center pier, is sloped down to 2′ over curb pier and 12½″ over the abutment wall to provide for drainage of the deck and also for the decreased resisting moment required in the shorter sidewalk slabs. These slabs were designed as continuous over supports for a moment WL/10 with span taken at right angles to piers, the paneled parapet beam being designed to take care of the load coming onto it owing to the skew of the bridge. The reinforcing bars were bent up over the piers to provide the same amount of reinforcing as in the bottoms of slabs. The deck was constructed as one monolithic slab without expansion joints.

To enhance the appearance of the structure a reinforced rail, consisting of a panel with a series of square openings on the diagonal set between concrete posts over piers and abutments, was placed upon the parapet girder. The illustration gives some idea of the excellent appearance of the structure mainly due to the straight-line architectural treatment, which conveys the idea of massiveness and stability.

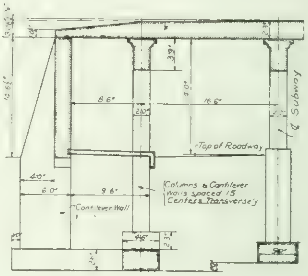


Fig. 2—Half Cross-Section

The bridge was designed for a live load approximately equivalent to Cooper's E-60, the slabs being computed for this load uniformly distributed with impact added in accordance with the formula

$$I = \frac{L.\,L. \times L.\,L.}{D.\,L. + L.\,L.}$$

The unit stresses used were:

Tension in steel	16,000 lbs. per sq. in.
Cross-bending compression in concrete	650 " " " "
Shear in reinforced concrete	60 " " " "
Bond on deformed bars	100 " " " "

Where it was necessary to lap reinforcing bars a lap of 40 times the least diameter was used. All exposed edges of the structure were given a 1-in. chamfer.

This bridge was designed by the D. L. & W. R. R. engrg. dept., G. F. Ray, chf. engr., and A. B. Cohen, concrete engr., and was built by the W. H. Gahagan Contr. Co.

Organizations

American Concrete Institute, Leonard C. Wason, President, 27 School St., Boston.

American Concrete Pipe Association, Secretary, E. S. Hanson, 538 S. Clark St., Chicago.

American Highway Association, Colorado Bldg., Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C.

Association of American Portland Cement Manufacturers (Portland Cement Association), J. P. Beck, Gen. Mgr., 111 Washington St., Chicago.

Cement Products Exhibition Co., 208 S. LaSalle St., Chicago, Ill.; Robt. F. Hall, Secy.

Mid West Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb.

Second National Conference on Concrete Road Building, J. P. Beck, Secy., 208 S. LaSalle St., Chicago.

Chicago Engineers Inaugurate Preparedness Campaign

A group of engineers and contractors of Chicago and vicinity have co-operated in forming a Joint Committee on Military Engineering. The founders are members of leading engineering and contracting organizations of Chicago, including the local branches of the national engineering societies.

The purposes of the Committee are to further military preparedness among engineers, contractors and their associates by the following means:

1. Courses of lectures; 2. Assigned reading; 3. Studies and practical instruction in military engineering; 4. Assisting engineers to qualify as officers in the National Reserve Corps of Civilian Engineers; 5. Urging enlistment in and support for engineer troops of the National Guard and such other organizations as the government may create; 6. Furthering instruction in military engineering in training camps and the attendance in them of those qualified; 7. By such other means as from time to time may be deemed advisable.

The Joint Committee has already prepared a program covering the vital points outlined. The program is practically complete for a period extending from Apr. 20 to July 25. Something of interest will be taken up each week, including lectures by Lieut.-Col. W. B. Judson, Engr. Corps, U. S. Army; two lectures by Maj. P. S. Bond, Engr. Corps, U. S. Army; Lieut.-Col. Mason M. Patrick, Engr. Corps, U. S. Army, and several exhibition drills, terrain exercises and inspection trips under the direction and guidance of various officers of the Engr. troops of the Illinois Natl. Guard. Additions to the program will be made from time to time.

Engineers, contractors and their associates in Chicago and vicinity are invited to join. Correspondence should be addressed to the Secy., Robt. F. Hall, 111 W. Washington St., Chicago.

The directors of the Joint Committee are: Wharton Clay, Chmn.; Robt. W. Hunt, Vice-Chmn.; Robt. F. Hall, Sec.-Treas.; Bion J. Arnold, W. W. DeBerard, J. de N. Macomb, Jr., H. S. Baker, Robert I. Randolph and Vernon C. Ward, Jr.

New Publications

Detailed Report on Lewis and Gilmer County (W. Va.) for the West Virginia Geological Survey—By D. B. Roger, 660 pp., illust. with 30 half-tone plates and 12 figs., cloth bound, with maps in separate case; price, $2.00.

Concrete Feeding Floors, Barnyard Pavements and Concrete Walks—The Portland Cement Assn., Chicago, paper, 6″ x 9″, 8 pp., illust. Advantages of a concrete feeding floor to the farmer and the methods for constructing these floors are well presented in this interesting publication, which will be sent free on application.

Metal-Mine Accidents in the U. S. in the Calendar Year 1914—Technical Paper 129, compiled by Albert H. Fay, issued by the Dept. of the Interior, Bureau of Mines, Washington, D. C., paper, 6″ x 9¼″, 96 pp., illust.

A Limestone Tester—By Cyril G. Hopkins, Chief in Agronomy and Chemistry, University of Illinois, Urbana, Ill., paper, 6″ x 9″, 12 pp., illust.

Description of Mines Branch Laboratories—Bulletin No. 13. Canada Department of Mines, Ottawa, Ont., paper, 6½″ x 9¾″, 72 pp., plate illust.

Relation Between Properties of Hardness and Toughness of Road-Building Rock—By Prévost Hubbard and F. H. Jackson, Jr., Reprint from Journal of Agricultural Research, Department of Agriculture, Washington, D. C., paper, 7″ x 10¼″, 16 pp.

Apparatus for Measuring the Wear of Concrete Roads—By A. T. Goldbeck, Reprint from Journal of Agricultural Research, Department of Agriculture, Washington, D. C., paper, 7″ x 10¼″, 16 pp.

School of Mines and Metallurgy—University of Missouri, Rolla, Mo., paper, 6″ x 9″, 106 pp., illust.

Concrete in Cemeteries

The value of concrete for many purposes is daily obtaining an increased recognition in our leading cemeteries. Its permanency is no longer questioned, its decorative possibilities are having constant demonstration, and so cemetery superintendents and others having charge of the practical needs of the cemetery as well as its beautification and improvement are coming to depend more and more upon concrete for an almost endless variety of uses in the cemetery of today.

The many products which have their foundation in concrete are hardly known to many, but they furnish a diversity of effect which is of value in artistic buildings planned for the modern park cemetery. As a foundation for posts, as well as buildings, for floors, for many uses in the greenhouse, for curbs, gutters, driveways, the real value of concrete is rapidly being tested and proved. * * * In the color scheme, which must always be considered seriously, we find that concrete offers contrasts and blendings with environments which cannot be surpassed in any other material and the future will witness a general adaptation to many uses of which there is no thought now, for as myriad as are its uses concrete is really, one might say, in the infancy of its entire recognition by the public. More and more one is impressed by the demand for thought along every line of achievement. Act slowly in maturing plans and there will be less opportunity for regret, and if this is ever true it is in the case of the cemetery, which is not the habitation of those who will perhaps soon be away; it is the abode which should above all things anticipate permanency.—*Cemetery Beautiful.*

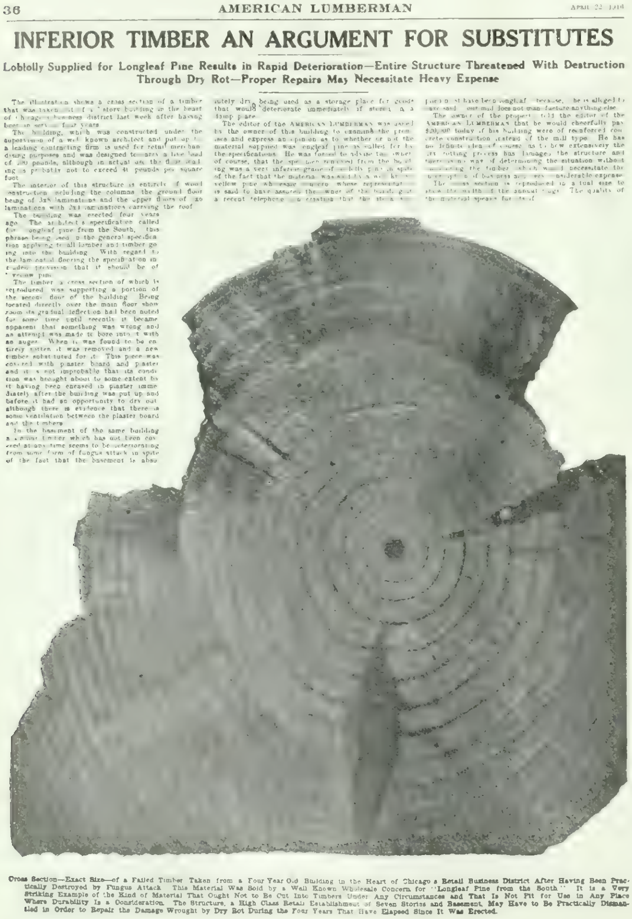
A Failure of Poor Materials —With Inadequate Inspection

Combating poor workmanship and the use of inferior grades of materials is a function not restricted to the conscientious leaders of any one industry. The accompanying reproduction of a page from a recent issue of the *American Lumberman* is an example of failure when lumber of inferior grade was used in a mill constructed building erected in Chicago about four years ago. The *American Lumberman* very properly condemns the direct cause of the failure, which was the substitution of inferior lumber. That such a state of affairs can exist in a building presumably erected and inspected by experts indicates the danger that may menace every mill constructed building.

The pity is that a comparatively small extra outlay would have provided the reinforced concrete building which the owner states he would gladly pay $20,000 to have in place of the present structure.

Concrete Markers on Yellowstone Trail

The accompanying illustrations show markers made of concrete on the Yellowstone Trail, a highway leading from Minneapolis and St. Paul to Yellowstone Park. Work on this road is being "boosted" by the states of Minnesota, North Dakota and Montana. The actual work of marking the trail is being done locally in counties and cities. In Bowman Co., N. D., the road is marked every ½ mi. with concrete posts 8″ x 8″ at the base, with tops 2′ 6″ high. These are painted a chrome yellow, which is the trail color. Where the trail enters Bowman, both on the east and on the west, there is a monument 7′ 6″ high, also made of concrete. In Edmunds Co., N. D., markers are being made in slab form of concrete, as shown in Fig. 2. They are 18″ wide and stand 3′ 6″ above ground. On the face of each slab is inscribed the name of the nearest town, both east and west, and the distances to them. The ordinary trail marker is used in Bowman Co. Small as it is, it is conspicuous, as is shown in Fig. 1, due to the topography of the country.



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INFERIOR TIMBER AN ARGUMENT FOR SUBSTITUTES

Loblolly Supplied for Longleaf Pine Results in Rapid Deterioration—Entire Structure Threatened With Destruction Through Dry Rot—Proper Repairs May Necessitate Heavy Expense

The illustration shows a cross section of a timber that was taken [illegible] story building in the heart of Chicago's business district last week after having been in service four years.

The building, which was constructed under the supervision of a well known architect and put up by a leading contracting firm, is used for retail merchandising purposes and was designed to carry a live load of [illegible] pounds, although in actual use the floor loading is probably not to exceed [illegible] pounds per square foot.

The interior of this structure is entirely of wood construction including the columns, the ground floor being of 3x8 laminations and the upper floors of [illegible] laminations with [illegible] laminations carrying the roof.

The building was erected four years ago. The architect's specification called for longleaf pine from the South, this phrase being used in the general specification applying to all lumber and timber going into the building. With regard to the laminated flooring the specification included provision that it should be of yellow pine.

The timber, a cross section of which is reproduced, was supporting a portion of the second floor of the building. Being located directly over the main floor show room its gradual deflection had been noted for some time until recently it became apparent that something was wrong and an attempt was made to bore into it with an auger. When it was found to be entirely rotten it was removed and a new timber substituted for it. This piece was covered with plaster board and plaster and it is not improbable that its condition was brought about to some extent by it having been encased in plaster immediately after the building was put up and before it had an opportunity to dry out, although there is evidence that there is some ventilation between the plaster board and the timbers.

In the basement of the same building a similar timber which has not been covered at any time seems to be deteriorating from some form of fungus attack in spite of the fact that the basement is absolutely dry, being used as a storage place for goods that would deteriorate immediately if stored in a damp place.

The editor of the AMERICAN LUMBERMAN was asked by the owner of this building to examine the premises and express an opinion as to whether or not the material supplied was longleaf pine as called for by the specifications. He was forced to advise the owner, of course, that the specimen removed from the building was a very inferior grade of loblolly pine, in spite of the fact that the material was sold by a well known yellow pine wholesale concern whose representative is said to have assured the owner of the building in a recent telephone conversation that the stock [illegible] must have been longleaf because, he is alleged to have said, "our mill does not manufacture anything else."

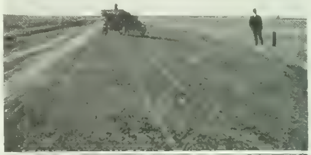
The owner of the property told the editor of the AMERICAN LUMBERMAN that he would cheerfully pay $20,000 today if his building were of reinforced concrete construction instead of the mill type. He has no definite idea, of course, as to how extensively the dry rotting process has damaged the structure and there is no way of determining the situation without uncovering the timber, which would necessitate the interruption of business and very considerable expense.

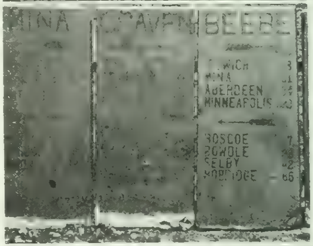
The cross section is reproduced in actual size to show the width of the annual rings. The quality of the material speaks for itself.

Cross Section—Exact Size—of a Failed Timber Taken from a Four Year Old Building in the Heart of Chicago's Retail Business District After Having Been Practically Destroyed by Fungus Attack. This Material Was Sold by a Well Known Wholesale Concern for "Longleaf Pine from the South." It is a Very Striking Example of the Kind of Material That Ought Not to Be Cut Into Timbers Under Any Circumstances and That Is Not Fit for Use in Any Place Where Durability Is a Consideration. The Structure, a High Class Retail Establishment of Seven Stories and Basement, May Have to Be Practically Dismantled in Order to Repair the Damage Wrought by Dry Rot During the Four Years That Have Elapsed Since It Was Erected.

A Beam from a Mill Construction Building Four Years Old

(This illustration about one-fourth actual size)





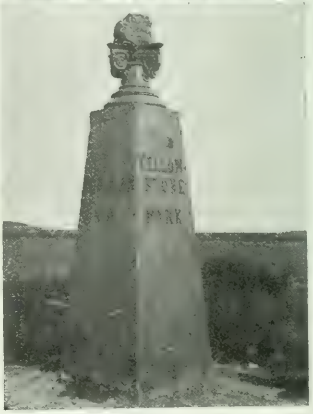


Fig. 1—Yellowstone Trail Marker As Used in Bowman Co., N. D.

Fig. 2—Trail Marker As Used in Edmunds Co., N. D.

Fig. 3—Monument on Yellowstone Trail, One of These Marking Entrance on Both the East and the West Side

Aggregate Studies at the Winnipeg Aqueduct[1]

By James H. Fuertes

The Greater Winnipeg Water District is now building works for securing by gravity about 100,000,000 U. S. gals. of water per da. from the Lake of the Woods, which lies about 100 mi. east of, and some 300′ higher in elevation than the City of Winnipeg.

Under the terms of the contract the District agrees to deliver the sand and gravel to the contractor at a stated price per cu. yd. Actually the District is shipping these mixed, but billed as sand and gravel in accordance with the ratios of the volumes that the sand and gravel would make separately, these having been determined from an extended laboratory study of the materials. It would be impossible, within space limits, to do justice to this phase of the subject. Owing to the percentage of sand in the gravel pit it is necessary to dig considerably more material than can be made into concrete aggregate. Thus in August there were excavated at the pit approximately 24,000 cu. yds. of material, of which 6,000 cu. yds. was stripping and 18,000 cu. yds. of sand and gravel; of the 18,000 cu. yds., 13,000 cu. yds. were concrete aggregate, a large proportion of which contained 50% of sand, and 5,000 cu. yds. was ballast and foundation fill material. It is desirable that the percentage of sand in the concrete aggregate should not exceed 35% of the whole in order to have an economical concrete. With a larger percentage of sand the amount of cement required to make a watertight concrete has to be increased. With a proper proportioning of the materials, particularly of the sand, by using certain percentages of sand passing the 100-mesh screen, it was possible to make concrete that was watertight under 80 lbs. pressure per sq. in., with about 1 Canadian bbl. (350 lbs.) of cement per cu. yd. of concrete.[2].

From a long series of samples of the materials from test pits in the gravel deposits at the pit it was found that the average run of the better samples contained about 3.3% of fine sand passing the 100-mesh sieve, the percentage of sand to total wide limits. It was also recognized aggregate varying between quite that it would be desirable from the point of view of economical development to use as large a proportion of sand in the final aggregate as safety would permit, bearing in mind that the amount of cement required to make tight concrete should be kept in a minimum. The allowable percentage of sand was finally fixed at 35% of the total aggregate, by weight, and the series of tests for permeability is based largely on this percentage, although a few tests were made with larger and smaller percentages.

Fig. 1, made up from the data obtained in the tests, shows the percentages of fine sand (passing the 100-mesh sieve) required to make watertight concrete with 10% of cement (370 lbs. of cement per cu. yd. of set concrete) when the sand is 35% by weight of the total aggregate, with varying percentages of intermediate and coarse materials.

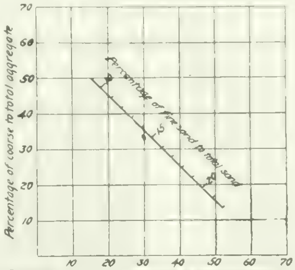


Fig. 1. Percentage of intermediate to total aggregate

Using 12% cement, with sand having 3.3% passing the 100-mesh sieve, watertight concrete could be made with sand varying from 23% to 43% of total aggregate and with intermediate and coarse, in equal proportions varying from 77% to 57% respectively, or, if coarse were absent, with sand at 35% and intermediate at 65%. Fairly good results were obtained with 12% cement, even with 49% sand and 51% intermediate, but this concrete slowly absorbed considerable water, showing a fairly large percentage of very small voids.

In order to be on the side of safety, in starting a new plant, the minimum quantity of cement that has been used when aggregate containing 35% sand has been shipped out, has been 12%, corresponding to about 1.27 bbls. (Canadian) to the cu. yd. The first cut in the gravel pit, arranged for a convenient layout for operating conditions, has taken the excavating machines into a part of the deposits running high in sand, and in order to keep the total sand in the finished aggregate down to 35% required a considerable wastage of sand after screening, which cuts down the net output and increases the amount of material to be handled. As the demands of the contractors have taxed the plant heavily, due to a number of causes, among which were delays due to breaks in machinery, lack of storage for the mixed aggregate, shortage of cars at times when the haul was long, or when large amounts of foundation fill materials were being shipped, it was found necessary, at times, to ship out material containing 50% sand, and in some cases, pit-run material. In such cases the cement has been increased to about 15% or 1.7 bbls. (Canadian) per cu. yd. This policy is very expensive, however, as it increases the cost of concrete to the District by about $1.00 per cu. yd. net, over the cost of concrete made with an aggregate containing 35% of sand. As the estimated volume of concrete in the whole aqueduct is about 330,000 cu. yds., the District is, this winter, planning to open another pit, equipped somewhat differently, near the eastern end of the line, to relieve the pressure on the existing plant both by furnishing more aggregate and by shortening the haul, thus getting better efficiency out of the transportation equipment.

The mixed sand and gravel is loaded into 20-yd. air-dump cars at the screening plant, hauled to the contractor's platforms and dumped. The cars are loaded, as nearly as possible to a loose measurement of 23 cu. yds., then scaled, and billed out to the nearest even yd. below the scaling. Of 110 cars loaded and billed out, in one test, 15 contained by scaling 22 cu. yds., 75 contained 23 cu. yds., 19 contained 24 cu. yds. and one contained 25 cu. yds. The total measured yardage in the cars was 2583.1 cu. yds., and the total billing was 2536 cu. yds., a difference of 47.1 cu. yds. or 1.85% more material shipped than billed for, due to taking the nearest even yd. below the scaling; or, roughly, the deliveries averaged nearly ½ yd. per car in excess of the billing. A further excess of deliveries over billing, in cars leveled off for measurement, also arises from the mechanical effect of the consolidation of the material in the cars of measured aggregate by the men when leveling off the cars. For example 17 cars were measured at the plant, then leveled off and trimmed. Before leveling, the measured contents was 392 cu. yds. and after leveling off 380.6 cu. yds., a difference of 11.4 cu. yds., or 3% shrinkage due to consolidation by the men's feet.

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[1] Extract from a paper read Oct. 18, 1915, before the Western Soc. of Engrs.

[2] Summary of tests given in extended tabular form as insert in Journal of the Western Soc. of Engrs., Nov., 1915

The relative weights of the aggregate per cu. ft. under different conditions as to moisture and compacting are shown in the following table, the sand in the moist aggregate being about 37% by weight.

Weight per cu. ft. loose and moist	114 lbs.
Weight per cu. ft. shaken and moist	122 lbs.
Weight per cu. ft. tamped and moist	132.5 lbs.
Weight per cu. ft. loose and dry	125.0 lbs.

from which it will be seen that the percentage shrinkage from the loose and moist condition to loose and dry was 9.65% and to shaken and moist 7% and to tamped and moist 15.8%.

The shrinkage in volume during transportation from the pit at mi. 30.8 to different points along the line is shown in Table 1.

In order to determine the ratio of aggregate billed out from the plant to the yardage of concrete put in place, measurements of both aggregate yardage and yardage of concrete laid were kept by all the division engineers for a week. Owing to inaccuracies in trimming the bottoms of trenches and to the small excess quantities of concrete in the arch sections, due to hand finishing the tops a little higher than the theoretical lines, the payment concrete averages less than the actual quantities placed. These ratios are shown to be about as follows:

Total cu. yds. of aggregate billed .... = 3,633.2
Total cu. yds. of concrete laid .... = 3,422.7

Excess of aggregate over total concrete .... 210.5 = 6%
Total cu. yds. of aggregate billed .... = 3,633.2
Total cu. yds. of payment concrete .... = 3,310.7

Excess of aggregate over payment concrete ...... 322.5 = 10%
Yardage of total concrete. = 3,422.7
Yardage of payment concrete .... = 3,310.7
Yardage of excess concrete = 112.0 — 3.4%

COSTS OF PREPARING AGGREGATE

The average cost per cu. yd. of the aggregate, for preparation exclusive of overhead charges, and transportation to the contractor's platforms has been as follows:

Excavation	$0.118
Hauling to plant	.081
Screening and crushing	.189
Loading	.061
Repairs to plant	.019
Repairs to cars, crane and dinkey	.011
Office	.005
Fuel	.123
Total	$0.507

It is expected that this cost will be materially reduced in the coming season.

To Increase the Products Manufacturer's Sales

A small manufacturer of concrete products may be greatly handicapped in advertising his work by the expense necessary in getting out advertising literature which is sufficiently attractive to do justice to the products the use of which the literature is intended to promote. Manufacturers using Ideal equipment[1] will be interested in the fact that the Ideal company has issued a very attractive little booklet entitled "Ideal Ideas," showing examples of work with Ideal machine products in various localities, and printed in two colors. These booklets are available for manufacturers using Ideal equipment and can be purchased at very low cost, due to the fact that they have been issued in very large numbers. They can then be printed with the name of the local manufacturer.

TABLE 1

Shrinkage in yardage of aggregate during shipment from mile 30.8 to different points along the aqueduct line.

(Aggregate 50% sand; 4 cu. ft. cement to 16 cu. ft. aggregate = about 1.7 bbls. cement per cu. yd. of concrete.)

Date	Mile at Which Sand Was Delivered	Cu. Yds. Billed	Cu. Yds. Measured at Pit	Cu. Yds. at Plant After After Leveling and Trimming	Cu. Yds. as Measured at Point of Delivery	Ratio of Billed to Cu. Yds. Measured at Delivery	Ratio of Cu. Yds. Measured to Cu. Yds. Delivered and Measured There
Aug. 26	40	23	23.6	22.2	21.8	1.055	1.08
Aug. 26	43	46	46.6	44.2	43.3	1.060	1.08
Aug. 27	51	46	46.2	46.2	42.2	1.090	1.09
Aug. 27	57	69	69.6	67.8	66.6	1.045	1.055
Aug. 27	65	69	[1]68.1	68.1	64.1	1.075	1.06
Aug. 27	71	45	45.4	44.3	41.5	1.085	1.095
Aug. 27	77	45	45.4	44.8	40.8	1.100	1.110
Aug. 27	85	46	45.8	45.0	42.4	[2]1.085	1.08

[1] Car leveled up for measurement at plant and settled in process of leveling

[2] Side doors of car raised in transit about 2" and some material leaked out

The Ransome Concrete Machy. Co., established in 1892, has just been reorganized. E. L. Ransome, founder of the company, is generally regarded as the father of the concrete machinery business and he remains with the new company as Chairman of the Board of Directors, and Consulting Engineer. The new men in the company are: Frank L. Brown, Pres. and Mgr.; G. F. Steele, Howard K. Brooks, F. M. Smith, H. M. Brittan, Directors; A. J. Norton, Sec.; J. J. Givens, Treas. Offices of the company are at 115 Broadway, N. Y. C.

T. W. Levalley, who has been Pres. and Gen. Mgr. of the Chain Belt Co. since he became its founder in 1891, has resigned the presidency and been made Chairman of the Board of Directors. He is succeeded as president by W. C. Frye.

The amount of heat generated depends upon the size or mass, the kind of cement used, the consistency of the mixture, also the richness of the concrete. For a 1:2:4 mixture, in mass 12" thick or more and of medium consistency, placed at 70° F. would develop in 24 hrs. to 36 hrs.' time a temperature of perhaps 120° F. to 150° F. I consider it not safe to count on this temperature to resist freezing. It is certainly not safe to consider this internal heat in building construction.—WARREN A. HOYT.

The E. I. du Pont de Nemours & Co., Wilmington, Del., has just printed a *Clay Blasting Booklet.* As it is the first booklet ever issued on this subject it contains valuable and interesting information. Some of the subject covered are Digging Clay, Stripping, Blasting Down Shale, Digging Plastic Clays, Mining Flint Clays, Draining Clay Pits, as well as full information on the use of explosives. The book will be sent to any address upon request.

In feeding a continuous mixer by shovel, see that all of the material is fed at the loading end. It is not uncommon to see at least one of the shovel men feeding his material at the dumping end.

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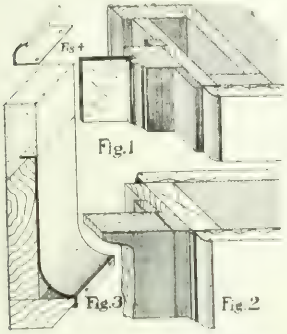
[1] Ideal Concrete Machy. Co., Cincinnati

New Equipment, Methods and Materials:
New Tools with Which the Industry Works □ □



METAL MOLDINGS FOR SANITARY TRIM

Sanitary Trim Easily Secured with New Materials

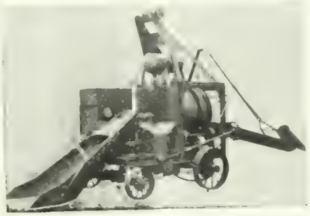
The increasing demand for sanitary buildings and fireproof construction has brought out many specialties little dreamed of a short time ago.

A series of products[1] recently placed on the market are cold drawn from heavy steel. They are designed to replace wood to secure an effective trim at a small expense. A study of the illustrations will make the methods of application clear.

Fig. 1 shows the application of the trim to a window frame and Fig. 2 to a typical inside partition, while Fig. 4 is a detailed section of the metal. It will be noted that the return of the bead forms a secure lock in the plaster.

Fig. 3 shows the same idea applied to a sanitary base. This trim forms a base and also acts as a plaster ground, assuring a perfect joint. Another specialty not illustrated is a new type of corner bead which seems to present certain advantages. It is stated that the use of this metal trim is very economical and that it is being extensively used in schools, hospitals and industrial buildings of fireproof construction. It would also seem to have a considerable field in modern residence work.

The commercial development of machines, tools and materials, and the new methods which their use involves have a most important part in the progress of the concrete field. Announcements of such developments, particularly in reference to their demonstrated importance in actual practice, are welcome. The Editors will select for publication that material which conveys the information of most practical value to the Reader, without regard to other considerations.



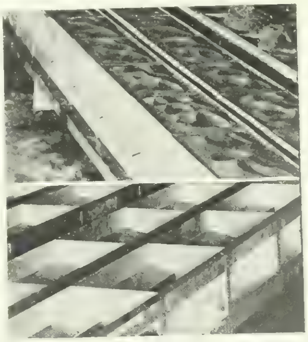
Small Paving Mixer

The new Lansing paver[1] is designed for the man who occasionally puts in a few block of street or concrete alley paving. It is light and so compact it can actually be operated in a 6-ft. alley. The drum easily holds, and mixes without slopping, 1 sack of cement, 3 parts sand and 5 parts stone; in other words, a 1:3:5 mix. It propels itself forward or back at a speed of 1½ mi. per hr. The power is supplied by a 6-h. p. Novo[2] or an Ideal[3] engine; these are regularly used, although steam power is furnished to all who prefer it. The mixer discharges into a sectional swinging chute and the concrete is run directly into place without further handling other than spreading.

Levers have been grouped so that one man attends to loading, discharging and spouting.

MacArthur System of Wet-Made Block

The MacArthur system[1] for making block involves a set of gang molds made of 18-ga. galvanized steel which may rest either on a plank platform or on a car. These molds make block which are of I-section, as cast, but when set in the wall are turned over so that the I is horizontal. These block are made face up. The chief advantage of the system is that a mixture of concrete approaching the ideal in consistency can be used—a sticky, plastic mixture, and not a dry-tamp mixture, nor a slushy mixture. One user of this equipment describes how manufacturing operations are conducted. Molds or forms are set in rows on 2-in. x 10-in. plank 14′ long, after the molds have been dipped into paraffin oil to keep the concrete from sticking. The mixture of concrete used for the body of the block is 1:4. The mold is filled to within 1¼″ of the top. This is allowed to stand for from ½ hr. to ¾ hr.; in this time the mix has settled slightly, leaving a space of about ½″ depth in which to apply a facing mixture. This may be of whatever character is required by the nature of the work. Any kind



BELOW IS SHOWN A GANG MOLD SET UP TO RECEIVE THE CONCRETE MIXTURE; ABOVE IS SHOWN A PART OF A SEPARATE MOLD FILLED of special aggregates may be used and a coarse, rough texture which is to be brushed out or washed later on can be employed. There is no danger with the face-up method of molding that the coarse aggregates will drop out of the facing. They can be firmly pressed into the backing and applied in such a way as to give excellent results. This system of molding block should lend itself very readily to the use of brushed out facing effects where the block is allowed to set for various lengths of time, depending upon the weather and other curing conditions and then brushing the face with a stiff bristle brush to remove the mortar from the face of the selected aggregates.

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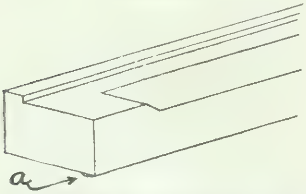
[1] Carter Sheet Metal Works, Omaha, Nebr.

[1] The Lansing Co., Lansing, Mich.
[2] Novo Engine Co., Lansing, Mich.
[3] Ideal Engine Co., Lansing, Mich.

[1] MacArthur Cement Products Co., Burlington, Ia.

The face design shown in the illustration cannot be strongly recommended from an aesthetic standpoint but the consistency of the concrete is very well shown, indicating that a plastic, sticky mixture can be used.

Haggard Bros., concrete products manufacturers at Browning, Mo., say that they have no difficulty in getting 3 cts. each more for these block made with a wet mixture of concrete than for ordinary dry-tamp block.



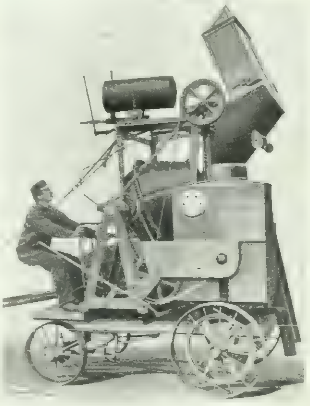
The Illustration Shows About Half of a Typical Sill; the Drip Slightly Exaggerated in the Drawing is Shown at *A*. Special Note is Made of the Water Lock Shoulder

Special Window Sill Molds

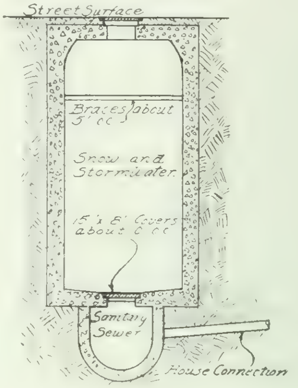
A good business has been built up in N. Y. C. in manufacturing a special patent type of sill. This is being done by the Portcement Stone Co.,[1] the originator of the special molds in which the sills are made. Having established a business in the manufacture of the product itself in these molds, and having had the sills adopted by reputable architects for good building construction, the molds are now being put on the market. But two molds are required for a wide range of work, each having a large cast iron base. One is equipped to make sills from 1' to 6' in length, 6" to 12" in width, and either 4" or 5" thick. The other machine makes any length of sill from 1' to 4' 4" and of the same widths and thicknesses as produced by the larger machine. Molds turn out a sill which has a wash, drip and a water lock shoulder, which is the principal feature of the sill. In spite of these features, which are demanded in sills, it has been possible for the manufacturers to sell the sills at 20 cts. per ft. for the 4-in. thick sills and 25 cts. per ft. for the 5-in. thick sills. Marble sills, according to the manufacturers in Brooklyn, cost 25 cts. to 28 cts. per ft. for a 4-in. thick sill only 4" wide, and 30 cts. to 35 cts. for the 5-in. thick sill. To make the sill outlined in the accompanying illustration, the molds have separate plates, gate ends, adjustable ends, etc., for different widths, with special provision to take care of the rabbets in the mold which form the water lock shoulder. The sill is made on a pallet. It is then turned over and carried away, when the machine is ready for the next sill.

Paving Mixer of 10 cu. ft.; Unmixed Material

The Wonder paver,[1] with a drum capacity of 10 cu. ft. of unmixed material per batch, weighs 7,500 lbs. The mixer utilizes the tilting drum principle and combines traction and paver features which recommend it for getting about on the small job, or for use possibly in pairs on bigger work. The availability of the machine is not confined entirely to paving work. It is equipped with an 8-h. p. vertical gasoline engine and the manufacturers say that it will climb a 20% grade, where there is a fair footing. The feature of fast mixing is not so strongly urged by manufacturers as it used to be, since it has been pretty well established that fast mixing is not good practice, but rapid loading and swift discharge and the possibility of quick removal from place to place are features which appeal to contractors. The mixer is equipped with distributing chute 12' long and can be made to discharge at 6', 9' or 12'.



The Wonder Paver



Typical Section of Sewer

New Combined Sewer and Snow Disposal System

A newly patented sewer,[1] made possible by reinforced concrete construction, includes as one of its features rapid snow disposal at trifling cost. The snow is swept into the sewer and hauling is avoided. It is possible to convert this sewer from a combined system to a separate system or vice versa without involving any cost or reconstruction.

The sewer consists of a longitudinal channel extending to the under side of movable street surface covers to permit of the insertion of snow. In the lower portion of this channel, which takes snow and stormwater, means are provided for the sanitary flow without danger of the solid matter swept with the snow from coming into contact with the flow and backing it up. Provision is also made for combining the two flows. Used in connection with inverted roadway crowns, catch-basins are unnecessary. Sub-structures are not interfered with and can be arranged to avoid tearing up and general disturbance.

It is claimed that the saving on snow disposal soon pays the entire construction cost.

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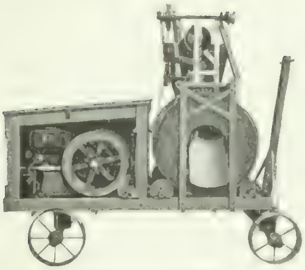
[1] Brooklyn, N. Y.

[1] Waterloo Cement Machinery Corporation, Waterloo, Ia.

[1] L. Davidson, N. Y. C.



The Kelly Concrete Mixer

A Reliable Low Cost Mixer

A mixer recently placed on the market after long-time practical tests is shown by the illustration.[1] The capacity of this mixer is 6 cu. ft. of loose material. The heavy steel drum is chain driven by a 3-h. p. gasoline engine which is equipped with a magneto. The mixer is furnished in a number of combinations equipped with a batch hopper, power loader, automatic water tank and hoist as desired. The hoist has a capacity of 275′ of ¼-in. wire rope.

Efficient Reinforcing is a Feature of a New Block for Silo Construction

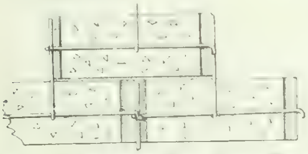


Fig. 1—Section of Silo Block Wall, Showing Arrangement of Reinforcement

A new type of silo block has recently been placed on the market[2] after a trial of several years in practical local use. The use of this block builds a silo with comparatively thin walls but without exposed reinforcing and one so bonded as to form an almost monolithic construction. It will be seen from the illustration, Fig. 1, that the block has a longitudinal rod with the ends bent over at right angles. It will also be seen that a vertical rod is molded into the block and projects in such a way as to come in the joints of the course next above. The abutting ends of the block are provided with a large semi-circular groove which takes care of the reinforcing and provides a liberal cavity for grout. The interlocking of the reinforcing and subsequent grouting provide a continuous reinforcing, both horizontally and vertically.

Fig. 2 illustrates the machine on which these blocks are made. It will be seen that a frame is provided with the machine which holds the vertical rod in place as the block is being formed. The machine is of the stripper type, the block being forced up through the mold and at the same time being given a troweling action that results in an exceptionally dense surface.

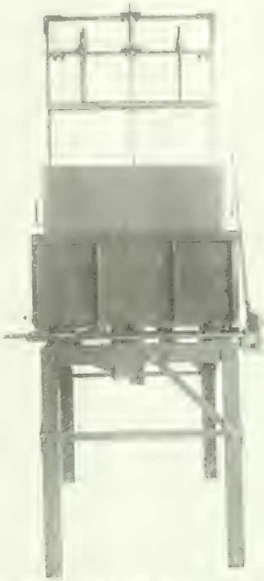
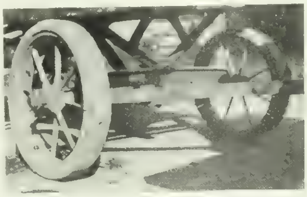


Fig. 2—Machine for Silo Block Manufacture

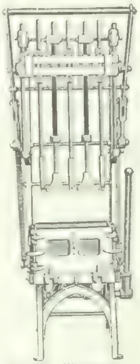
Old Rubber Tires Smooth Road for Mixer

The contractor who uses a motor truck for hauling equipment has often found that it is impossible to haul his mixers at even a slow truck speed without shaking them badly. The Baumgardner Concrete Products Co.[1] has solved the problem by using an old set of motor truck solid tires. These were attached to the mixer by cutting out a portion of the steel rims to which the solid tires are attached and having the rims curved to the new arc. They were then bolted to the mixer wheels through holes drilled for the purpose and the tires vulcanized. It is found that this allows much more freedom in hauling the concrete mixer.



Concrete Mixer with Rubber Tires from Motor Truck

Tamper for Attachment to Block Machines



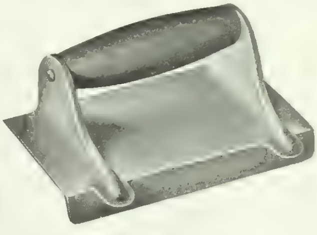
Baute Tamper Over Ideal Block Machine

The accompanying illustration shows the Baute[1] tamper, which is adjustable to any of the tamp block machines. It is operated by pulling down the horizontal bar shown across the top in the illustration. It is recommended by the manufacturer on the basis of being much more even and systematic in its tamping and also for the fact that it will make possible the production of 50% more block than can be done with the use of a hand tamper. The machine can be adjusted for making ¼, ½ and ¾ block.

New Edger Insures Straight Lines

A new tool for finishing the edges of concrete work which prevents uneven lines has recently been perfected.[3]

As will be seen by the illustration the tool resembles an ordinary edger with two projecting lips. These ride on the edge of the form, keeping the work perfectly true, provided the form is straight.



An Improved Edger

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[1] F. H. Clarke Mfg. Co., Cleveland

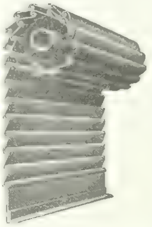
[2] Geo. C. Harvey, Geneva, Ohio

[1] Tiffin, Ohio

[1] Baute Concrete Machy. Co., Benton Harbor, Mich.

[2] Ideal Concrete Machy. Co., Cincinnati

[3] H. L. Park Co., Reading, Mass.



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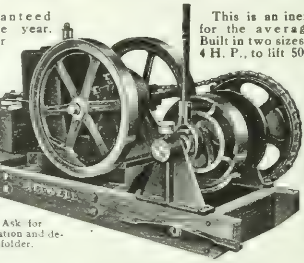

This is an inexpensive hoist for the average contractor. Built in two sizes 2½ H. P. or 4 H. P., to lift 500 lbs. or 1,000 lbs. 100 ft. per minute, or double this capacity at half the speed. Not a gear on it. Operated by one lever. 18 in. drum. An ideal machine for lifting brick, mortar, concrete or other building material.

Price is low Ask for our quotation and descriptive folder.

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Milwaukee, Wis.

Current Prices — Concrete Materials □

Portland Cement—Prices on cement are in general about the same as quoted for last month. Prices given are f. o. b. cars at points named, including cloth sacks, for which, in general, 40 cts. per bbl. (4 sacks) is refunded on return in good condition. Pacific Coast cement manufacturers now allow only 7½ cts. each for bags returned instead of 10 cts. as previously done. This is equivalent to a raise of 10 cts. per bbl. in price. Prices per bbl. (including four cloth sacks) are as follows: Boston, $1.92; New York, $1.72; Chicago, $1.86; Pittsburgh, $1.81; Cleveland, $1.34 to $1.94; Cincinnati, $1.84; Detroit, $1.90; Indianapolis, $1.99; Toledo, $1.94; Milwaukee, $1.83 to $1.98; Minneapolis and St. Paul, $1.08 to $2.13; Duluth, $2.06; Peoria, $1.94; Cedar Rapids, $1.90 to $2.05; Davenport, $1.80 to $1.95; Denver, $1.87; Toronto, $1.75; Montreal, $2.00; Winnipeg, $2.60; Vancouver, $2.75; Spokane, $2.35; Seattle, $2.30; Portland, Ore., $2.40; Tacoma, $2.30; San Francisco, $2.15; Kansas City, $1.82; Omaha, $1.98; Oklahoma City, $2.09.

Crushed Stone—1½-in. stone, prices per cu. yd., f.o.b. cars in carload lots, unless otherwise specified. New York, 85 cts., in full cargo lots at the docks; Chicago, $1.00; Winnipeg, $2.50; Vancouver, $1.50; Spokane, $1.00; Portland, Ore., $1.15; Seattle, $1.50; San Francisco, $1.25.

Gravel—Prices given are per cu. yd. f.o.b. cars in carload lots unless otherwise noted. New York, 80 cts. in full cargo lots at docks, Chicago, $1.00; Winnipeg, $1.85; Vancouver, $1.50; Spokane, $1.00; Portland, Ore., 85 cts.; Seattle, 75 cts.; Tacoma, 75 cts.; San Francisco, 90 cts.

Sand—Prices are per cu. yd. f. o. b. cars in carload lots unless otherwise indicated. New York, 40 cts., full cargo at docks; Chicago, $1.00; Winnipeg, $1.85; Vanouver, $1.25; Spokane, $1.00; Seattle, 75 cts.; Portland, Ore., 85 cts.; Tacoma, 75 cts.; San Francisco, 80 cts.

Reinforcing Bars — The prices here here given are only approximate since they fluctuate greatly and few mills are taking business even at the figures given. At the present time practically all business is being taken on a basis of $3.00 per cwt., Pittsburgh, with prevailing extras for bars under ¾″ or base, and for delivery in second quarter, except in special cases, where a premium is paid. The following are quotations on base bars per 100 lbs., for mill shipments from other points, f. o. b. cars: New York, $3.159; Philadelphia, $3.159; Chicago, $3,189; Spokane, $3.05; Portland, Ore., $2.70; Seattle, $2.70; Tacoma, $2.70.

Shipments from stock are being made at the following prices per cwt. f. o. b. New York, $3.10; Buffalo, $2.95; Cincinnati, $3.20 to $3.75; Cleveland, $3.25; St. Louis, $3.15; Chicago, $3.10; St. Paul, $3.20; Toronto, $3.00; Vancouver, $3.00; Spokane, $3.90; Portland, Ore., $3.60; Tacoma, $3.60; Seattle, $3.60.

Metal Clips for Supporting Bars—$4.50 to $6.50 per 1,000, depending on size.

For the majority of the prices given we are indebted to the Universal Portland Cement Co., Sandusky Portland Cement Co., Concrete Steel Co., Dewey Portland Concrete Co., American Sand & Gravel Co., Chicago, and F. T Crowe & Co., Seattle, Portland, Spokane and Tacoma.

Reinforcing bars for mill shipments are in general sold on a Pittsburgh basis: that is, at the Pittsburgh quotation plus the freight to the point in question, and with the following list of freight rates on finished material and the Pittsburgh quotation given, the price of bars at any of the points listed can be readily computed.

From Pittsburgh, carloads, per 100 lbs. to:

Albany	16.9	cts.
New York	16.9	"
Philadelphia	15.9	"
Baltimore	15.4	"
Boston	18.9	"
Buffalo	11.6.	"
Cleveland	10.5	"
Birmingham	45	"
Cincinnati	15.8	"
Chicago	18.9	"
Denver	68.6	"
St. Louis	23.6	"
New Orleans	30	"
Minneapolis	32.9	"
Indianapolis	17.9	"
Kansas City	43.6	"
Omaha	43.6	"
Pacific Coast Points (Rail)	73.9	"

Now that the Panama Canal has been opened to traffic ocean freight rates on reinforcing bars to Pacific Coast points have been established which materially lower the delivered cost of bars from the east. The rates per 100 lbs. to Pacific Coast points for large lots are. From Pittsburgh, 61.9 cts.; Chicago, 76.5 cts.; Youngstown, 61.9 cts.; New York, 40 cts.; Bethlehem, 52.9 cts.

Concrete

Vol. 8 Detroit, June, 1916 No. 6

The Growing Scarcity of Labor Threatens Construction Work

THE unprecedented industrial conditions in this country have had a decided effect on the labor market. This is evident even though the season is not at the height of activity and farm demands are not at the maximum seasonal activity.

A recent investigation by *Engineering Record* shows that wages have advanced in the northeastern section of the country, represented by a line drawn along the western boundary of Minnesota around Missouri and back to Washington, D. C. In this territory is concentrated 61% of the population of the U. S. Southern New England, southern New York, Pennsylvania and New Jersey and a small area northwest of Chicago are reported as feeling a sharp scarcity of men. Manufacturing has greatly increased and with money unusually easy it seems unlikely that conditions will be modified in the early future.

Immigration tables show that the normal per annum increase of Italian laborers in New England has been about 13,000 and in New York about 26,000. Since June 30, 1914, not only has this increase stopped but New England has lost 22,000 and New York 64,000 Italian laborers alone. Official figures do not show that this is being offset by other immigrants while it is certain that laborers of other nationalities have left in considerable numbers.

The Aberthaw Construction Co., Boston, has made a survey of the situation as it affects the East and the results indicate that 30 cts. and very likely more will be paid for an 8-hr. da. this summer. The employment bureaus have reported a labor scarcity dating back to Aug., 1915. Reports from labor unions show only 4% unemployed from June, 1915, to Jan., 1915,—the lowest in years. Another indication is the high per cent of want ads which call for unskilled labor.

The West and the South seem to have sufficient common labor but as the proportion of population is small in these sections it is unlikely that they will be able to relieve the situation in any marked degree.

There's Nothing Like Preparedness for a Test

SOME concrete structural tile made by the Delta Brick and Tile Co., Detroit, were delivered on a job recently—the job being in the immediate vicinity of a clay brick yard. The concrete tile have been giving common brick hot competition—up to the limit of capacity of the tile plant. Somebody informed the Dept. of Bldgs. that the tile were of poor quality and should be tested. Almost anybody can secure a test on demand. The Chief Inspector of the Department notified S. H. Wightman, manager of the Tile company, that samples of his tile from the job near the brick yard would be tested at 9 o'clock the next morning, the samples having been taken by the Department. The first tile broke at 1,748 lbs. per sq. in.; the second one at 1,915 lbs. per sq. in. (net area). The minimum requirement of the Detroit building code is 1,000 lbs., with a required average of 1,500 lbs. The test was the 29th made on the Detroit tile showing an average net crushing strength of 2,600 lbs.—the lowest, 1,485 lbs., the highest, 3,207. Mr. Wightman is convinced that there is nothing like preparedness all the time.

Concrete Trusses are Outcome of Steel Situation

THE difficulty of securing structural steel for long-span girders and trusses has naturally turned the attention of designers to reinforced concrete. This is not only true of the friends of concrete but designers who have hitherto refused to consider concrete for such purposes are being forced to give its use their attention. It is only logical to assume that they will learn much to their advantage.

In view of the situation and the very limited amount of literature available on this subject CONCRETE is fortunate in being able to publish in this and in the succeeding number a comprehensive presentation of the development and design of roof trusses, especially prepared by A. M. Wolf at the request of this magazine. Further contributions out of recent experience are welcome.

Machinery vs. Hand Labor

RAISING labor costs cannot fail to stimulate thought as to how mechanical equipment can be employed to keep down the ultimate cost of construction work. It is probable that from the present situation will be evolved wider use of labor saving equipment now available and the introduction of new methods to increase the production per man employed. The present condition is regrettable but out of it should come valuable knowledge.

Are Architects Too Conservative

WHY are architects, as a class, indifferent to improved devices? Any salesman calling on architects will confirm the statement that, collectively, architects do not readily accept new methods and materials.

Doubtless a very proper conservatism toward untried materials is prompted by the desire to protect clients from unsatisfactory results, but is it not equally desirable to give them the comforts and economies made available by careful investigation backed by technically trained judgment?

It is common to find a passive attitude on the part of the architect even toward proved commodities and in numerous instances the client actually has to "sell" his architect materials with which the architect has not become familiar. The architect should use his technical training not only to protect his client from unworthy materials but to aid him in selecting the best that can be obtained.

Competition

THE best thing that can happen to any industry is to get cooperation among all the minds devoted to it. If one man is putting on stucco to stay and another man's work is going to pieces, the news of the failures is spreading faster and farther than the news of the successes. The result is that the business of the man doing good work is actually injured by the other fellow. Composition floors, to which this magazine gave some attention in Jan., 1916, supply a striking example of this inevitable situation. A good many jobs of composition floor laying have been bungled. The legitimate manufacturers and contractors in this field have a hard situation to combat.

Many times this magazine has pointed out how important is cooperation among all the workers in the concrete fields. Each issue of this magazine is evidence of the fruits of co-operation. One man asks, another man answers—one man has a certain job to do, another man has already solved the problems involved. The man who *knows* is actually building up his own business if he helps the other fellow to achieve a success which will further the industry in which both are engaged.

In an address before the Portland Cement Assn., in Chicago, May 10, George T. Buckingham talked about modern competitors. Among other things he said:

> When the 19th century was young the competitor regarded his operations as secret. It was a calamity for one competitor to discover the facts concerning the business of another. Now all that has passed. The intelligent competitor of the 20th century turns the *sunlight of publicity* upon his affairs for the benefit of all in the same business. The first and fullest possible interchange of information, concerning the facts of common interest, in any given line are of the greatest possible benefit, not only to those engaged in the business, but to the public as well. The largest interchange of information tends to stabilize every industry, and to protect the public against unfair competitors, as well as to protect the competitors against the unfair action of the public.

Defining the Consistency of Concrete[1]

By Duff A. Abrams[2]

The conistency of concrete may be defined as the ratio of the weight of the water used in the mix to the total weight of defined materials in the batch. At the present time there is no well defined standard of consistency for concrete. Committee C-9 of the Am. Soc. for Test. Mat. on Standard Tests of Concrete and Concrete Aggregates has recommended the following method for determining the proper consistency of concrete for tentative use in laboratory tests:

Mix a small batch of concrete sufficient to make a 6-in. by 12-in. or 8-in. by 16-in. test cylinder. For this purpose a metal form with uniform diameter and smooth inner surface must be used. Place the concrete in the form in layers of 3″ to 4″ in thickness, using care to see that all the concrete is not thrown against one side of the form. After placing each layer, puddle the material with a steel rod about ½″ in diam. and 2′ or 3′ in length. This method of puddling serves to break up any arching of the coarse aggregates and to release entrained air or water. As soon as the specimen is completed, remove the form entirely from the fresh concrete by a steady upward pull. The form is to be removed without releasing the clamps or bolts which hold it together. Use care not to disturb the fresh concrete. The correct amount of water has been used when the specimen of fresh concrete shortens about ¼″ for a 6-in. by 12-in. cylinder, and a proportional amount for other sizes, upon removal of the form. The consistency determined in this way may be termed "Standard Consistency." It will be found that for 1:2:4 mix, this requires 7% to 10% of water, depending on the kind and size of aggregates. If the concrete specimen shortens more than the amount indicated above, too much water has been used for standard consistency. If no shortening is observed, the concrete is too dry for standard consistency.

The method of puddling by means of a steel rod furnishes a fair criterion of the proper consistency. If the concrete is mixed too dry the material cannot with any success be puddled in this way.

Such terms as "dry," "moist earth," "medium," "wet," "sloppy," etc., which are frequently used to describe the consistency of concrete, have no definite significance and their use should be discouraged. It will be noted that the consistency mentioned above is considered standard for use in laboratory tests. However, consistencies other than standard may be expressed as a percentage of standard consistency determined by the above method. Thus, what was formerly termed "dry" consistency, may be expressed as 80% of standard consistency; "wet" consistency as 125% of standard consistency, etc. For instance, it may be found desirable to define the proper consistency of concrete for use in road construction as, say, 120% of standard consistency.

Consistency should be defined in terms of the weights of materials used. The above method furnishes a definite means of expressing the amount of water required in any given case.

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[1] In a discussion of this subject at the National Conference on Concrete Road Building in Chicago, Professor Abrams described briefly methods of definitely determining standard consistency. Since then he has been able to make the discussion more complete and give it to the readers of CONCRETE—EDITORS

[2] Prof. in charge of Structural Materials Research Laboratory, Lewis Institute, Chicago

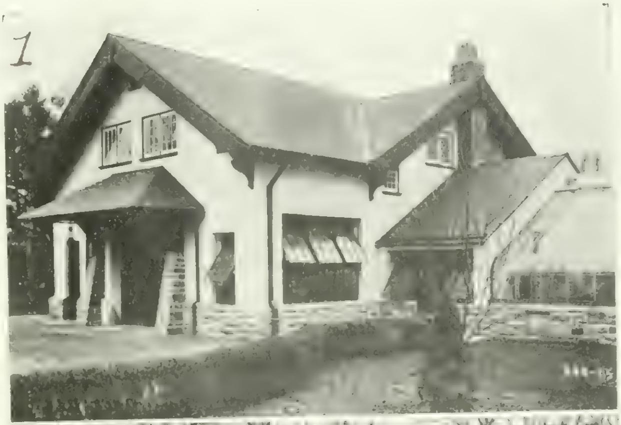
Suggestions for Building Private Garages of Concrete

The construction of the private garage is one of the everyday problems of both the architect and the builder. It presents an opportunity offered by few small structures to display resource in providing a fireproof building at moderate cost, a building that will have an individuality suited to its surroundings. There is endless opportunity to add refinement of detail. A suggestion that will sometimes add to the value of the proposed job for both owner and builder is its combination with some other building needed by the owner, a billiard room, studio, shop or den.

Salesmanship plays a large part in profitable fireproof garage construction; small garages can often be made profitable, but specialization is desirable as the contractor who builds 20 garages in a season can give better service and make a better profit than he who builds but one or two.

Prospects can be secured by working with local automobile dealers who generally know of contemplated buildings. Letters should be mailed to these people calling attention to the value of the fireproof garage and to the writer's ability to construct attractive fireproof buildings. Pamphlets and folders are available, describing various types of concrete garages and offering suggestions through attractive illustrations. A supply of these pamphlets can be obtained on request or at a nominal cost[1]; one or more should be sent with the letter. A return postal to make reply definite and easy should be enclosed. A prompt personal call following a response should be made and so far as time permits personal solicitation should follow all letters whether or not a reply is received.

In making calls the builder should carry as large a collection as possible of pictures showing garages of the kinds he is prepared to build. This collection should be, preferably, good photographs attractively mounted in a neat album, showing his own work, but may be supplemented by photos from other sources and by pictures clipped from magazines, etc., and by bulletins.



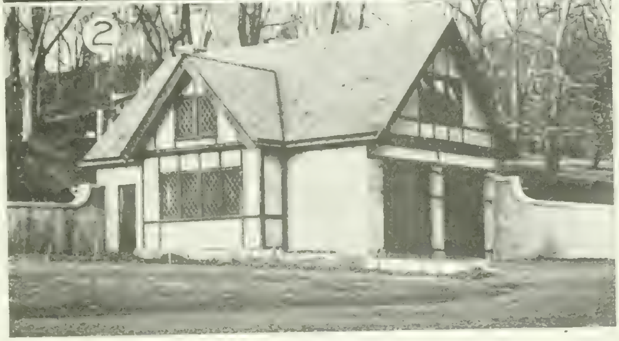


Fig. 1 Hollow Tile and Stucco, Concrete Floors
Fig. 2 Double Concrete Walls, Concrete Floors and Stucco

Fortunately the floor plans of most private garages are extremely simple; attractiveness and fireproof construction are the strong selling points. Study the site and the owner's tastes. Most automobile owners are able to spend a little more money to buy an especially pleasing building.

For a single car, garages are frequently built 13′ x 24′, which gives a 3-ft. space around a large car and room for a small bench. This size can be reduced, where space is not available, to 12′ x 20′, which is small enough. The owner can often be shown the wisdom of building a two-car garage even though no immediate need exists. This will provide for a visitor's car or the space can be rented. The extra cost is not great. A good two-car size is 23′ x 23′ inside, but this can be somewhat reduced.

CONSTRUCTIONS

Concrete garages may be classed in three types as to construction and finish: (1) stucco on block, tile or metal lath, (2) block and other units, (3) poured or monolithic construction. The order given probably indicates the relative numbers of each type built.

Stucco Garages—The illustrations,

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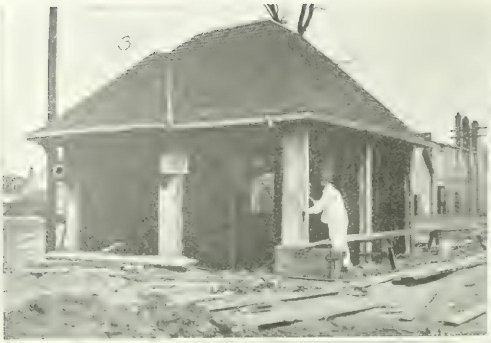
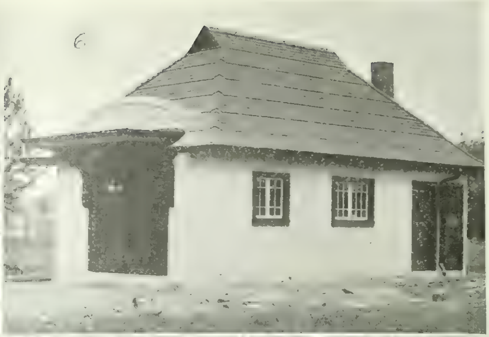
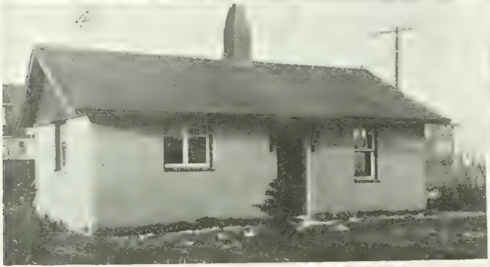
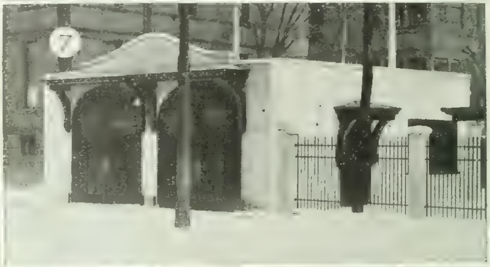
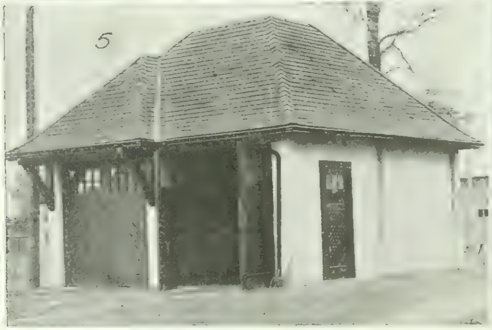
[1] Portland Cement Assn., 111 Washington St. W., Chicago; Alpha Portland Cement Co., Easton, Pa.; Atlas Portland Cement Co., 30 Broad St., N. Y. C.











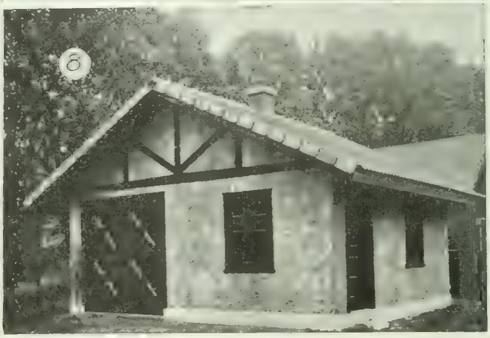


FIG. 3—POURED COLUMNS WITH METAL LATH AND STUCCO
FIG. 4—GARAGE AND STUDIO OF CONCRETE TILE AND STUCCO
FIG. 5—THE GARAGE SHOWN IN FIG. 3 COMPLETE

FIGS. 6 AND 7—SUGGESTIONS FOR DOOR TREATMENT; A FLAT ROOF IS ECONOMICAL
FIG. 8—ROUGH-CAST AND TILE

Figs. 1 to 12 and Fig. 20 show stucco on a variety of bases. Fig. 1 is a very high-class building with living quarters for employees and with a greenhouse in connection. Above the foundations the walls are constructed of hollow tile which were filled with concrete and reinforced at all jambs and every place along the walls that received concentrated loads. Interior partitions are built of hollow tile. The second floor is of Floretyle[2] construction with a wood roof and suspended ceiling on rib lath.[2] All windows, sliding and swinging doors are of United steel sash[2]; wired glass and fireproof putty were used, the entire interior is painted with Asepticote,[2] excepting portions of the bath room where Marine enamel[2] was used.

The garage illustrated in Fig. 2, while a monolithic building, is finished with stucco and is described by the builder, W. W. Schouler[3] as follows:

> The garage is 30′ x 20′, with living and storage quarters on second floor. First floor and second floor are of reinforced concrete. The first story is built of hollow monolithic walls consisting of two 4-in. walls with a 2½-in. continuous air space. The walls are holding 10′ of bank on two sides. Three hundred feet of retaining wall were built in the same manner, without forms, using a hollow wall machine.[4]
>
> The second story is of stucco on frame. The inside is plastered with patent plaster. Gas tank pump, work bench and electric lights are installed. Woodwork is stained dark and leaded glass windows are used. The second story was given a scratch coat and the entire building received a coat of stucco to get an even surface; then it was dashed with a mixture of 1 white cement, 2 sand and 3, ½-in. trap rock thrown on with brick trowel and paddle. Steam heater is in separate room, with outside door only.

Stucco on Lath—In Fig. 3 is shown a garage under construction, using poured concrete bearing posts with curtain walls plastered on Hy-Rib.[2] The finished building is shown in Fig. 5. The building shown in Fig. 4 is a combination building which faces the owner's garden and house. The entrance is into a studio which is separated by a fire wall from the garage proper, which is entered from the alley at the rear.

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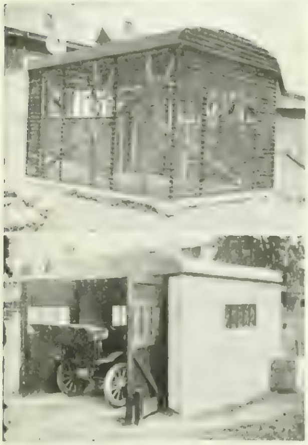
[2] Trussed Concrete Steel Co., Youngstown, Ohio

[3] Schouler Cement Const. Co., Newark, N. J.

[4] Van Guilder Hollow Wall Co., Rochester, N. Y.



Figs. 9-10—A Shelter Only, But Fireproof, Clean and Inexpensive

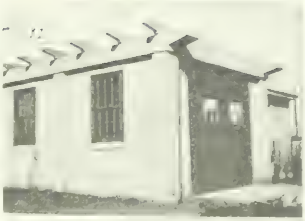


Fig. 11—A Rugged Building of Distinctive Design

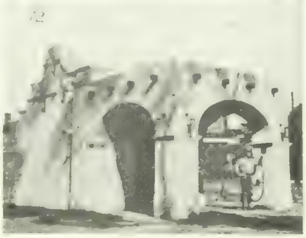


Fig. 12—Mission Architecture Makes a Gasoline Station Beautiful

A large, rough stone fireplace with concrete mantel and chimney is an attractive feature. This building is constructed of hollow concrete tile[5] covered with stucco, and left unfinished inside. The roof is shingled and stained a dull red. A hot water heater is installed in the studio.

Illustrations 6, 7 and 8 are other examples of metal lath and plaster construction. A number of methods are available for this work which is shown in its simplest form in Fig. 9. A frame of pipe, light angle iron or pressed steel lumber is erected and ribbed metal lath wired to the frame.

Four coats of mortar, two on each side, should be supplied, making a reinforced slab about 2″ thick, and a third coat dashed or troweled on as an exterior finish. Similar construction on wood frame is much used but is not desirable for garages.

A garage built and owned by Louis R. Williams, Bartlesville, Okla., is shown in Fig. 11. The walls are brick, 4-in. curtain walls being used. The building is 14′ x 20′, 9′ to under side of reinforced concrete roof beam.

The longitudinal beams are 8″ x 12″ in section and overhang the stucco 1″. A longitudinal beam helps support the 3-in. concrete slab roof which is dished to the center and slopes to an outlet at the rear. The cross-beams that give the pergola effect are 4″ x 8″.

The poured work was finished by brushing to expose the aggregates and the brick plastered both sides

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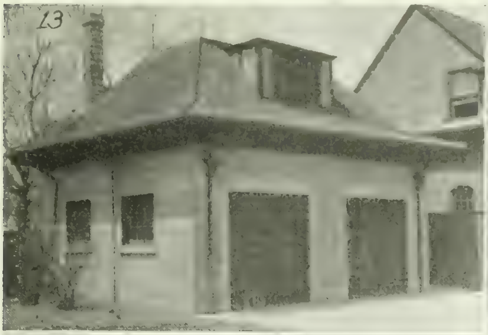
[5] Delta Brick & Tile Co., Detroit



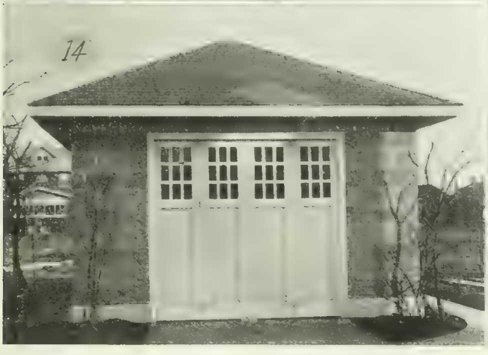
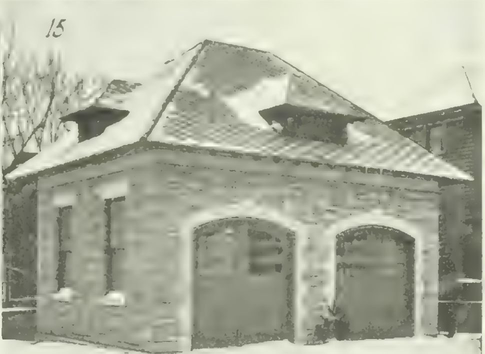


Fig. 13—Large Units and Tile Make a Dignified Building

Fig. 14—Plain Block in Two Tones



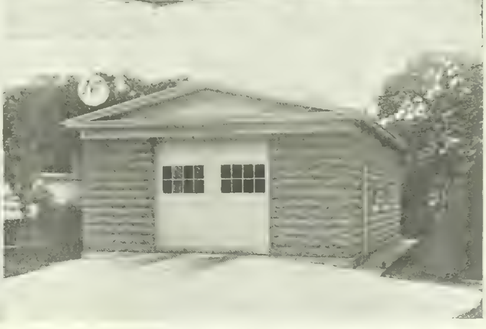


Fig. 15—Ashlar Laid Block, Careful Design and Good Work

Fig. 16—A Dignified Design; Plain Block Would Give a Better Effect

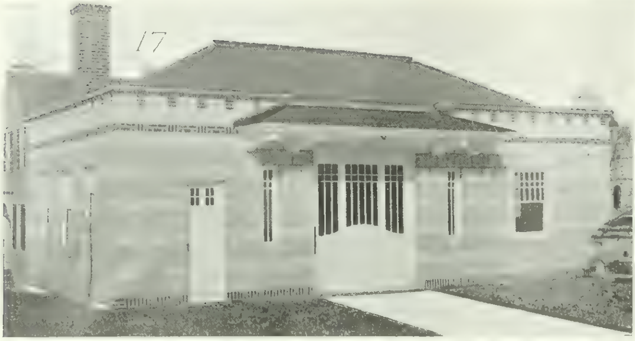


Fig. 17—Plain Block with Brick Trim; Work Like This Makes Friends

and the exterior pebble-dashed. Gas and water connections and electric lights are provided. Cost, $185.

City requirements are resulting in the erection of a large number of gasoline stations. Fig. 12 shows an attractive filling station at Los Angeles, Cal. The Mission architecture has been worked out in stucco and furnishes a valuable suggestion. A feature is the installation of the gasoline pump in one of the massive columns at the front.

UNIT CONCRETE GARAGES

Concrete units when well made and carefully finished make a excellent construction for a garage. Fig. 13 shows garage of plain-faced slabs built by W. E. Wagner, Toronto, Ont. The construction is very light and strong. It consists of thin concrete slabs set on edge and tied by concrete studs 2½" x 6", poured in place. Slabs are reinforced with wire mesh and left with a rough texture. These units have the effect of very large blocks. The roof is of metal tile.

A similar effect is shown, secured by the use of a rough-textured plain-face block,[7] in Fig. 14.

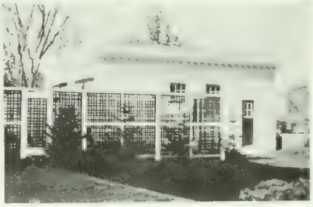


Fig. 20—All-Concrete Double Walls with Cornice Cast in Place

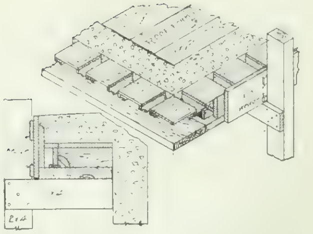


Fig. 21—Section and Isometric Views, Showing Form Details for Cornice

Other excellent examples of block garages are shown in Figs. 15 to 19. Fig. 15 laid in broken ashlar masonry is an excellent example of the work being turned out by modern equipment[8] in the hands of expert workmen.

The building in Fig. 16 shows a roof treatment that adds dignity and finish to a plain structure. The pretentious garage, Fig. 17, shows an effective use of plain block and brick trim. Illustrations 18 and 19 offer further suggestions. Fig. 19 shows a concrete roof.

MONOLITHIC GARAGES

A very tasteful garage is illustrated at Fig. 20 which possesses the distinction of being truly all-concrete.

This garage, 36' x 42', was built at Brookline, Mass., by the F. O. White Construction Co., Cambridge,

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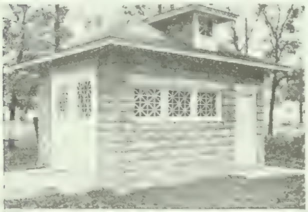
[7] Hydro Stone Co., Chicago

[8] Hobbs Concrete Machy. Co., Detroit



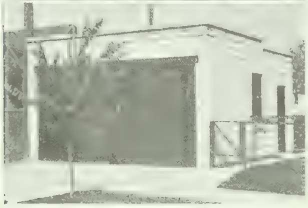


Fig. 18—Skillful Window and Door Treatment Makes This Distinctive at Little Increase in Cost

Fig. 19—Plain and Substantial Concrete Roof

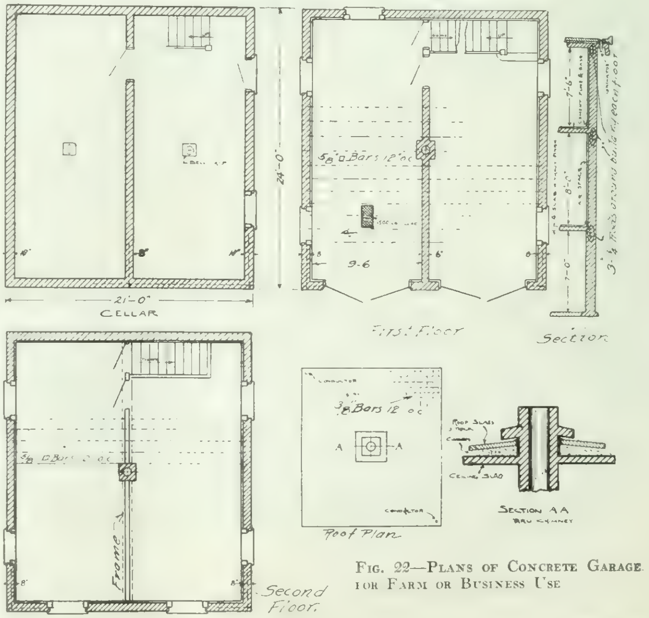


Fig. 22—Plans of Concrete Garage for Farm or Business Use

Mass. The walls are double, constructed with a hollow wall machine.[1] They were built up to the roof level and forms for a flat roof were placed; the cornice and its construction are shown at Fig. 21. The roof is 5″ thick reinforced with ⅝-in. rods 6″ o. c. transversely and 24″ o. c. longitudinally. A steel beam also supports the slab at its center longitudinally. The cornice forms are supported by poles and ledgers. The poles are securely tied to the building. A 12-in. plank forms the base on which open-end boxes are laid at suitable spacing. These boxes are held securely by a molding and strips which form the end of the bracket and insure perfect alignment. The remainder of the form is clearly shown. After pouring the roof and the cornice, the parapet wall was built with the wall machine. The box forms should be made slightly wider at the bottom and the corners rounded. Forms should be well oiled with paraffin oil.

At times it is desirable to combine other buildings with the garage.

Fig. 22 gives plans for a two-story and basement garage designed for a Pennsylvania farm by A. Morgan Smith.[9] The building is located in a bank so that the basement is accessible from a low level. The building is 21′ x 24′ and was poured in wood forms.

The floor slabs were designed for a load of 1,500 lbs. and were tested by placing the weight at W; no deflection was noted. The slabs are 4″ thick made of cinder concrete, reinforced with ⅝-in. square bars 12″ o. c. A 1-in. granolithic finish was placed for a wearing surface.

The building was furred and lathed to secure insulation and the outside walls were stuccoed. The roof is a 3-in. gravel concrete slab reinforced with ⅜-in. rods 12″ o. c. both ways. The concrete roof rests on a cinder bed entirely clear from the ceiling slab. The chimney was poured around an 8-in. stovepipe. The two floors give about 1,300 ft. area and the cost was about $1.00 per sq. ft.

Each year the city of Buenos Aires gives a cash prize to the architect of what is adjudged to be the most handsome building erected during the year and the owner receives a worth-while tax exemption. This idea is good and could be elaborated by forming several classes to secure separate prizes for business buildings, residences of varying cost, etc.

A 60-in. Monolithic Concrete Storm Sewer at Houston, Texas

By G. L. Fugate[1]

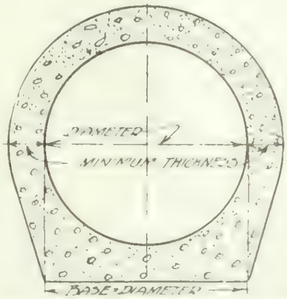


Fig. 1—Standard Storm Sewer Section, Houston, Tex.

The McGowan Ave. storm sewer, Houston, Tex., is a 60-in. monolithic concrete lateral to the Fourth Ward trunk line storm sewer; the trunk line has a section of 9′ in diam· at the junction point and is of the Parmley segmental concrete block construction.[2]

The McGowan Ave. storm sewer is the largest monolithic concrete sewer in the city, although larger ones are planned. It has a depth of 14′ to 20′ below the surface; the topography of Houston is almost level but has a slight slope away from the Houston Ship Channel, the outlet for all storm water; this requires the storm sewers to be very deep, and until recently the idea has been that monolithic construction, in the treacherous soil that is usually met with, would not be economical. In 1914 over 2 mi. of monolithic concrete sewers were constructed, ranging in size from 27″ to 60″, and from 8′ to 20′ deep. This has been found to be a very economical construction.

A standard plan for monolithic concrete storm sewer of different diameters is shown at Fig. 1. The empirical formula for finding the minimum thickness is: $T = \frac{1}{12} d + 2\frac{1}{2}$; where T min. thickness in in. and D=diam. in in.

Connection of the 60-in. monolithic concrete and 108-in. Parmley block was made through a junction chamber.

Table of Standard Sewer Data

Diam	Min. Thickness	Concrete per Ft.
30″	5″	4.38 cu. ft.
36″	5½″	5.82 ″
42″	6″	7.42 ″
48″	6½″	9.22 ″
54″	7″	11.23 ″
60″	7½″	13.41 ″
66″	8″	15.78 ″
72″	8½″	18.35 ″
78″	9″	21.11 ″
84″	9½″	24.06 ″
90″	10″	27.20 ″
96″	10½″	30.53 ″
102″	11″	34.05 ″
108″	11½″	37.76 ″
114″	12″	41.67 ″
120″	12½″	45.76 ″

The approach of the 60-in. sewer is on a curve having a radius of 54′ to center line and through a central angle of 57° 30′; the excavation was through strata of quicksand and the foundation had to be poured in small sections. Deformed bars were embedded in concrete so as to be sure of a good bond between the old and the new concrete. The excavation in the block containing quicksand was done with hand labor, the material being removed by cableway (Fig. 2). The surplus material was dumped from cableway bucket into wagons and hauled

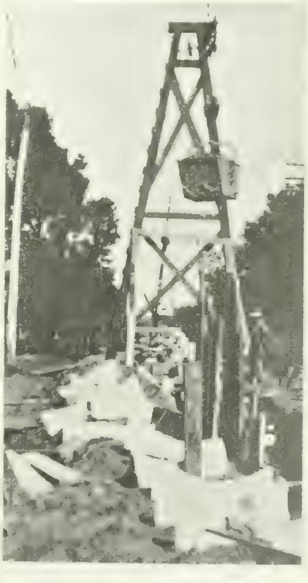


Fig. 2—Cableway for Excavating and Back-filling

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[9] Archt., Mt. Lebanon, Pa.

[1] Engr., Storm Sewers, Houston, Tex.

[2] Walter C. Parmley, N. Y. C.

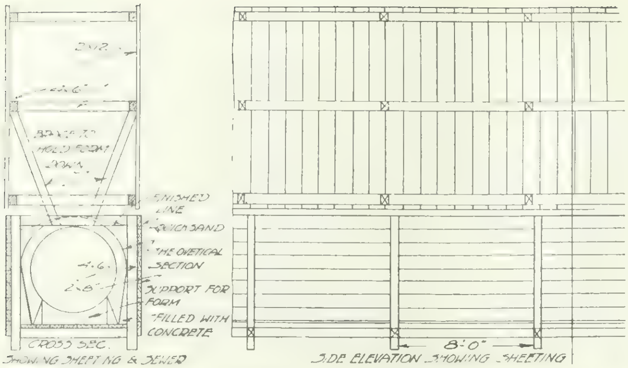

Fig. 3 Diagram of Trench Bracing

away; the material for back-filling was carried back of a completed section of sewer and dumped. This is a very economical way as the excavating and back-filling are done with one handling of the earth. The method of bracing and sheeting the trench through the quicksand is shown by Fig. 3, and gave very good results. The trench was excavated down to the quicksand and braced by usual methods, by rangers and upright sheeting. When the quicksand was reached the 4-in. x 6-in. posts were sunk until the ends were about 8″ below the bottom of the sewer; this was done by boring a hole with an 8-in. post-hole auger; the instant the auger was removed, men were ready with the post to place in the hole; sometimes it would require several operations, as the sand would come in as the auger was removed.

The next step was to get the bottom 4 x 6's in place; they were put in between the posts and the sand removed, until finally gotten into the correct position and spiked; the 4-in. x 6-in. posts were then braced at the top, so that there would just be room to slip the form under; the posts were spaced horizontally 8′ apart and after being braced at top and bottom excavation was started in the quicksand along the edge of the trench and as soon as possible a 2-in. x 8-in. piece of horizontal sheeting was placed; another section was taken out, the 2-in. x 8-in. being driven down as the excavation proceeded and another piece put in from above. After reaching grade a 2-ft. x 10-ft. floor was laid, and the forms immediately set; the concrete was poured to the top of the form and the 4-in. x 6-in. was removed; no top forms were used, but sewer finished as shown by Fig. 3; this gave an excess of concrete, but was cheaper than placing forms.

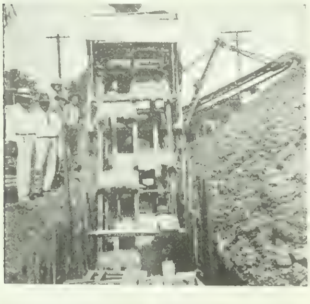

Fig. 4—Excavator at Work

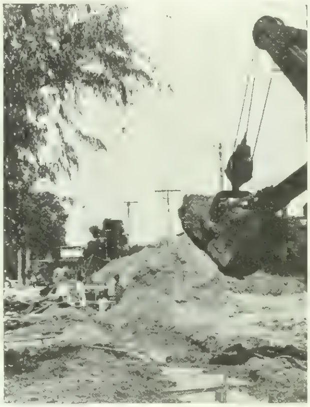

Fig. 5—Back-filling with Steam Shovel

After leaving the block containing quicksand the excavation was done with a No. 2 Austin excavator.[3]

The illustrations give an idea of the amount of dirt removed; some hand finishing was done in the bottom of the trench, this being necessary to get the theoretical section of the sewer.

Back-filling was done with a model 28 Marion steam shovel,[4], the surplus material being loaded by the shovel into wagons and hauled away. Considerable delay was caused by not keeping enough teams to keep the shovel going, as some of the hauls were long. The trench was filled about ⅔ full and water turned on until it stood above the fill; filling was then completed, the water running until street grade was reached.

FORMS

Forms used were the Keller collapsible steel forms.[5] The concrete anchor blocks were made at the contractors' plant and hauled to job on wagons.

In setting forms, the anchor blocks were placed on the sub-grade 3′ 10″ apart and under joints as shown at Fig. 6 to prevent forms from buckling. The first section of forms was placel in position, the angles at bottom, as shown at Fig. 6, and both ends tied through perforations to desired diameter; the spreader was placed in position in discharge end and expanded until tight. The second section was then placed in the forward end of first section and against the angles, the forward end tied with wire to desired diameter and spreader placed at bottom, the top being pushed into position and expanded until both sections were rigidly clamped; the third sections were then placed the same way.

Concrete was poured wet on top of forms and allowed to run off both sides, the sides being filled evenly to prevent springing of forms. Forms were collapsed by removing spreaders and clipping the wires inside the forms; in re-setting the forward sec-

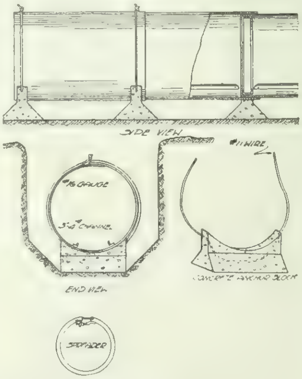

Fig. 6—Detail Showing Form Arrangement

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[3] Austin Drainage and Excavator Co., Chicago

[4] Marion Steam Shovel Co., Marion, Ohio

[5] Keller Collapsible Steel Form Co., Kansas City, Mo.

tion was drawn into position and reset and so until all were in place; these forms were used with good results in putting in the curve of 54-ft. radius.

This contract covered only the first section of the sewer as planned and will be extended in the future, the extension to begin with a 45-ft. sewer and reduced as required to a 20-in. sewer; in this contract there were 1,968′ of 60-in. monolithic concrete sewer constructed, 23 standard inlets and 6 standard manholes.

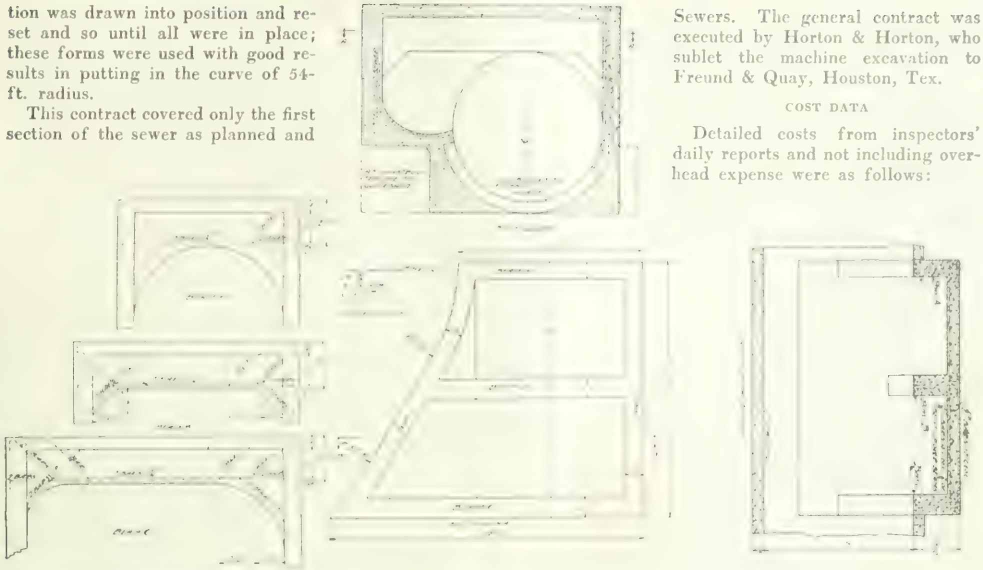

Fig. 7—Details of Junction Chamber

The junction chamber shown in Fig. 7 was a complicated structure, as will be seen by a study of the illustration.

The work was designed and supervised by E. E. Sands, City Engr., and G. L. Fugate, Engr. Storm Sewers. The general contract was executed by Horton & Horton, who sublet the machine excavation to Freund & Quay, Houston, Tex.

COST DATA

Detailed costs from inspectors' daily reports and not including overhead expense were as follows:

Cost Data Junction Chamber

Excavation and Bracing:

1,835.0 hrs. labor @ 20 cts..........$367.00
222.0 hrs. foreman @ 45 cts.......... 99.90
102.0 hrs. water boy @ 12½ cts.. 12.75
$479.65

130.0 cu. yds. excavated=$3.69 per yd. (Excessive cost due to quicksand)

Placing Concrete:

120.0 hrs. labor @ 20 cts............$24.00
40.5 cu. yds. concrete, labor cost, 59¼ cts. per cu. yd.

Building and Wrecking Forms:

84.0 hrs. labor @ 56¼ cts..........$47.25
68.0 hrs. labor @ 20 cts............ 13.60
100.0 hrs. labor @ 20 cts............ 20.00
$80.85

Labor cost for forms, $1.996 per cu. yd. concrete.

Note—After wrecking forms lumber had to be carried about 80′ through the 9-ft. sewer and taken out at manhole.

Placing and Handling Steel:

87.0 hrs. labor @ 20 cts.............$17.40
1,910 lbs. reinforcing steel placed at $18.22 per ton.

Note—Steel bent wrong and had to be taken out and re-bent.

Back-filling and Disposing of Surplus Material:

257.0 hrs. labor @ 20 cts............$51.40
50.0 hrs. team @ 60 cts............ 30.00
$81.60

130.0 cu. yds. back-filled, 62¾ cts. per cu. yd.

Note—This includes water tamping and hauling away the surplus material; several heavy rains on material before back-filling, making it very hard to handle.

Cost Data for Block Containing Quicksand

Costs based on labor at $1.75 per da. of 8 hrs. and $10 per da. depreciation on cableway, which includes erecting, etc. This does not include voerhead expenses or superintendence.

Excavation per cu. yd..................$0.794
Excavation per lin. ft.................. 4.18
Includes back-filling.
Labor cost bracing and sheeting, $3.771 per M. B. M. or $0.318 per lin. ft. sewer.
Labor cost setting forms, $1.046 per cu. yd. concrete or $0.231 per lin. ft. sewer.
Labor cost placing machine mixed concrete, $1.56 per cu. yd. concrete or $0.345 per lin. ft. sewer.

Machine Excavations

Based on engineer at $5.00 per da., fireman at $3.50 and $30 per da. for depreciation;

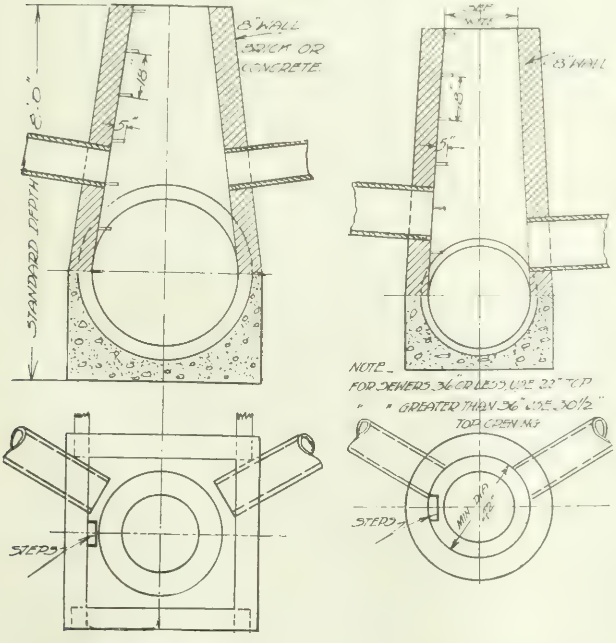

Fig. 8—Standard Manholes

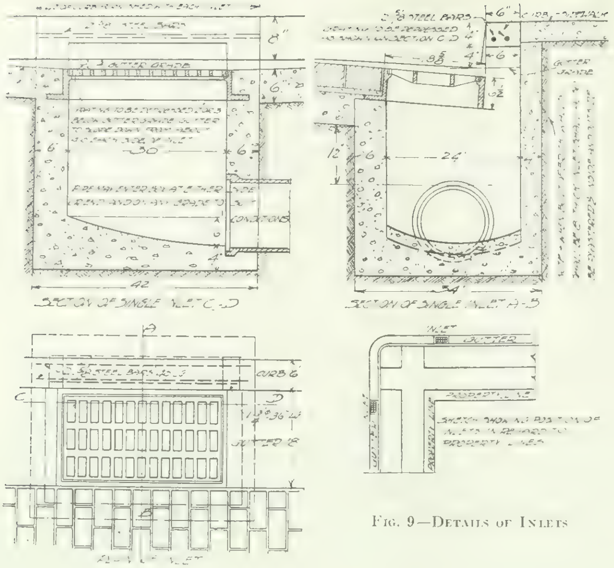

FIG. 9—DETAILS OF INLETS

does not include overhead or superintendence.
Excavation, $0.166 per cu. yd. or $0.76 per lin. ft. sewer.
Labor cost bracing and sheeting trench, $0.038 per cu. yd. excavation, $0.174 per ft. trench or $1.92½ per M. B. M. lumber.
Labor cost setting forms, $0.271 per cu. yd. concrete or $0.135 per lin. ft. sewer.
Labor cost placing concrete, $0.965 per cu. yd. concrete or $0.48 per lin. ft. sewer.
Labor cost back-filling with steam shovel and loading in wagons the surplus material, based on $15 per da. depreciation, engineer at $5.00, pit men at $2.50 per da., $0.11 per cu. yd. or $0.462 per lin. ft. sewer.

The total cost to the city for the completed sewer was $26,513.23.

Reducing Cost of Handling Cloth Bags[1]

As everyone knows who handles cement, the bags come back from the jobs with anywhere from ½ lb. to ¾ lb. of cement in each bag. Some little of this is shaken out by the man who counts the bags, but the most of it goes with the bag back to the mill, the dealer paying the freight on the entire weight.

The proposition of installing a bag cleaner was presented to us about six months ago and after careful consideration it was decided to try it out. The cleaner removes approximately ½ lb. of material from each bag, thus reducing the shipping weight to about 1 lb. for plaster bags. Now, estimating that you handle 250,000 cement bags in a year, there will be a saving of about 125,000 lbs. Our local freight rate on cement bags is 28.4 cts.; this means a saving in dollars and cents of $355.00. Supposing that you handle about 60,000 plaster bags from the Oakfield district, which take a rate of 32.3 cts. This will mean a reduction of at least 30,000 lbs. and a saving of $96.90. And then you may use about 30,000 White Finish bags from the Ohio district, on which you have to pay 38 cts. freight rate. Cleaning these bags will save about 15,000 lbs. in weight or $57.00. This makes a total saving in freight of $508.90. In addition to this, 125,000 lbs. of cement will be 329 bbls., for which you can find a ready sale at $1.00 per bbl. net, or a total of $329.00. This, you see, brings the total saving up to $837.90. The cost of operating the bag cleaner, interest on your investment, depreciation, etc., will not amount to more than $237.90. You now have a net saving of $600 on all bags handled during the year. We have not yet found a market for the shakings from the lime and plaster bags, but undoubtedly they could be disposed of for some purpose or other.

The cleaner which we use consists principally of a large drum-shaped affair, covered with wire mesh, against which the bags beat when the wheel revolves, thus knocking all the dust out and leaving the bag clean. The bags are thrown into the drum and after being revolved 10 min. or 15 min., they are dropped out on a conveyor, which carries them to one end of the cleaner where they are removed and bundled ready for shipment. In addition to the saving from the use of the bag cleaner, the bags are in much better condition to count, and when the shipments are received at the mill, they will undoubtedly receive much better attention.

How the Contractor Can Advertise and Get Results

"How can a general contractor advertise?"

Which, of course, means how can he obtain the right kind of publicity; the kind that will do more than fill advertising space and cost money—in a word, the kind that pulls?

The principles of advertising are the same whether you are endeavoring to sell books, bricks or office buildings or seeking to get your name on the architect's lists. The only things that change are the manner and methods of publicity. A general contractor must therefore adopt methods suitable to his own particular business, which, by the way, is decidedly different from any other type of business, and must have its advertising done and copy written by men who understand, in a most comprehensive manner, the details and intricacies of the building trade.

Then, again, the advertising must be of a twofold nature, inasmuch as its appeal must reach both architects and owners—two different types of men, and in most cases with very little in common so far as their training is concerned.

To the architect, the builder's advertisement must appeal with such riveting force as to be ever before him. If not in a physical manner, at least mentally it must make a little dent in his mind and "ring the bell" at the psychological moment when the architect is making up his list of bidders, and the nearer the top of the list the better his chance of always being among the favored few.

You may say that you already do enough estimating and are now working overtime trying to land jobs. Are you on the lists of all of the prominent architects, the men for whom you would like to estimate? Are you in a position to select the good prospects and avoid the poor ones? In a word, are you competing against men who do the same caliber of work that you are doing, or are you forced out of your class because you are not on the chosen lists? If you cannot answer these questions to your entire satisfaction, then you are ready for serious thought on the question of advertising—*Exchange.*

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[1] By B. C. Downey, in the *Atlas Almanac*

Reinforced Concrete Roof Trusses
Types in Use—Design Methods

By Albert M. Wolf, C. E.[1]

The use of reinforced concrete for roof trusses does not cover a very long period as compared with other structures. Many engineers and architects are now considering the use of reinforced concrete trusses who heretofore have turned a deaf ear to even the mention of the possibility of such construction. Illustrative examples of concrete truss construction will be of special interest to the builder, the engineer and the architect.

The almost entire absence of literature on the subject of roof design warrants the very complete treatment given it by the author. In July, 1916, design and construction methods will be treated.

GENERAL DATA AND EXAMPLES

In the earlier days of the concrete industry in this country it was the general practice to use plenty of concrete and steel rather than indulge in any refinements of design; the material added thus made up for approximations of design due to lack of knowledge of the action of the materials under load. Simplicity in design and construction was sought for, above everything else. This was quite natural, since the materials used were relatively cheap as compared with the cost of labor, and to effect economy meant to cut down on labor cost wherever possible. This precludes the design and use of such structures as Europe abounds in, namely, those exemplifying a combination of highly theoretical and rigid mathematical design and the utmost economy in the use and deposition of materials. The reason is, that in Europe designers have always sought to effect greater economy in the use of materials since they and not the labor were the costly items. With the present high and still advancing prices of materials conditions are gradually approximating those prevalent in Europe, as American engineers are very keenly realizing, and the result no doubt will be the use of what have heretofore been called daring designs.

The main objection to concrete in long-span construction is the excessive dead weight, which, where the live loads to be carried are relatively small (as for roofs), becomes a large percentage of the total weight considered as acting. Any method of reducing the dead load by omitting concrete wherever possible is, then, a step in the right direction. For long-span roof construction and for framing to carry skylights over wide courts and for railway station work, the concrete truss is the logical solution where fire-resisting construction of the best type is desired or required, since the materials are so placed as to give the greatest carrying capacity for the minimum amount of dead load.

The first reinforced concrete trusses used in America were of the Visintini type 24′ long and were built in connection with the Textile Machine Works, Reading, Pa., in 1904. These are described in another place in this article.

In Europe, Vierendeel trusses (so named from the inventor, Prof. Vierendeel) with parallel chords have been used quite frequently in both building and bridge work. These are in general constructed with members all of the same cross-section and with square panels (same height and length), although in some cases broken top or bottom chords have been used (Fig. 12). The external loads are considered as applied, at the panel points. These are statically indeterminate structures and the analysis is made on the basis of the elastic behavior of the truss, it only being necessary to determine the bending moments since the compressive, tensile and shearing stresses are dependent upon them. Trusses of this type have been constructed with spans up to 80′ (bridge), but this is not the maximum permissible, according to Vierendeel. Trusses of the Visintini type are also used quite extensively in Europe. These consist of trusses with parallel chords divided into panels by vertical members connected by single diagonals for long spans or without verticals for comparatively short spans (see Fig. 17). The stresses in these trusses are computed in the same manner as for the ordinary Pratt or Warren truss of steel. Visintini trusses of 105-ft. span (highway bridge) have been constructed in Europe, and some excellent examples can also be found in American practice.

In general it can be said the reinforced concrete roof trusses of other than the most simple types are uneconomical as compared with structural steel or wood, but if a fireproof construction is required it will be found that for ordinary spans reinforced concrete trusses are cheaper than structural steel trusses encased in concrete. This is true because of the more economical arrangement of steel permitted by the use of bar reinforcement, the difficulty of constructing forms around structural steel members and the greater amount of concrete required to encase structural steel tension members as compared with tension rods in reinforced concrete.

The above, of course, would not be true if a concrete truss of the same type as would be most economical for structural steel were used. Concrete is especially adapted for compression members and, if properly reinforced, a truss of a smaller number of panels can be used for the reinforced concrete truss. This cuts down on the amount of formwork and hence on cost. The use of reinforced concrete trusses with more than four to six panels, except for Vierendeel or Visintini trusses, should not be encouraged, for with an increase in number of panels the weight increases very rapidly. The ordinary two-panel king-post, three-panel queen-rod and the simple Pratt, Fan and Fink trusses (Fig. 13) and parallel chord Pratt and Warren trusses (Fig. 14), are best adapted for reinforced concrete construction.

The T-beam with the stem reinforced as a column is the most suitable shape to employ for top chord members and especially so where the trusses form a monitor skylight, this shape giving more lateral stiffness to the truss. Where king-post trusses are used they should be tied together by a ridge girder into which intermediate lines of T-beam rafters frame (Fig. 1a). With three-panel and four-panel trusses longitudinal roof girders or purlins should be used to support the roof slab directly or, if such slab spans are very long, rafter beams carrying the slab reinforced at right angles to the purlins, should be used (Fig. 1b and c).

Where openings occur in the roof a type of framing should be used which will give a minimum amount

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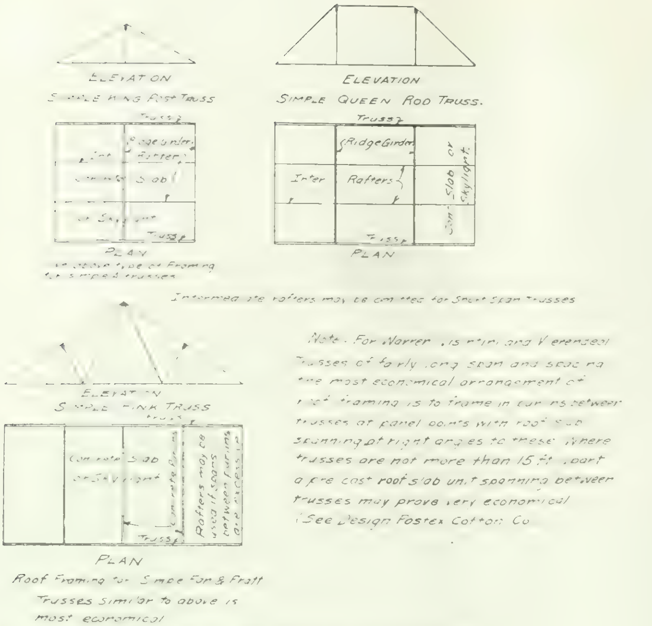
[1] Assoc. M. Am. Soc. C. E., Chicago


ELEVATION
SIMPLE KING POST TRUSS
Truss
Ridge Girder
Inter Rafter
Concrete Slab
or Skylight
Truss
PLAN
Use above type of Framing for simple trusses
ELEVATION
SIMPLE QUEEN ROD TRUSS.
Truss
Ridge Girder
Inter
Rafters
Conc. Slab or Skylight
Truss
PLAN
Intermediate rafters may be omitted for Short Span trusses
ELEVATION
SIMPLE FINK TRUSS
Truss
Concrete Slab or Skylight
Concrete Purlins
Rafters may be used if spans between purlins are excessive
Truss
PLAN
Roof Framing for Simple Fink & Pratt Trusses similar to above is most economical

Note. For Warren, Visintini and Vierendeel Trusses of fairly long span and spacing the most economical arrangement of roof framing is to frame in purlins between trusses at panel points with roof slab spanning at right angles to these. Where trusses are not more than 15 ft. apart a pre cast roof slab unit spanning between trusses may prove very economical (See Design Fostex Cotton Co

FIG. 1—ROOF FRAMING FOR VARIOUS TYPES OF CONCRETE TRUSSES

of concrete for the portion between trusses. Then also the roof deck forms should be as simple as possible, so as to reduce to a minimum the number of supports required, since if the trusses are located at a considerable height above the floor directly below, as in a craneway, the cost of construction will be greatly influenced by the amount of centering required. Under such conditions if the spans of trusses are considerable the most economical construction may be to concrete the trusses in place (if too heavy to handle as units) and erect the rafters or purlins and slabs as pre-cast units, thus confining the centering to a very small portion of the work.

The following descriptions are of American designs for reinforced concrete trusses and are of much interest, since they indicate the rapid progress made in the art in a little over 10 yrs.

VISINTINI TRUSSES, TEXTILE MACHINE WORKS, READING, PA.

As previously noted, the first use made of Visintini trusses in America was in the construction of the Textile Machine Works plant at Reading, Pa., in 1904-5. The trusses, 24′ long and spaced 12′ 6″ o. c., support Visintini beams 6″ deep placed side by side to form the floors and roofs. The beams forming the floors were designed and computed like a Warren truss with all of the web members inclined at 45°, half of them being in tension and the other half in compression.

The trusses between columns 25′ 1½″ o. c. have verticals and single diagonals. They are 24′ long, 2′ ¾″ deep (for floors), 12″ wide and designed as Pratt trusses with tension diagonals and compression verticals, the chords being 4¾″ thick and the diagonals and verticals 2½″ thick. The diagonals are inclined at 45°, giving panel lengths of 20″. The bars in the diagonals are bent at the ends to form eyes through which the chord rods pass. The vertical members, being in compression, are of plain concrete. The details of these trusses are shown in Fig. 2.

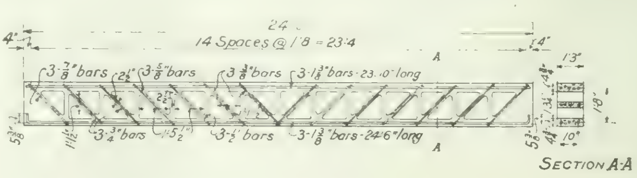
The trusses, weighing about 3 tons each, were molded on the floor directly underneath their final position in the work and when properly seasoned were hoisted into place by a special derrick and two hoists.

The advantage of this type of construction is that the weight and the volume of concrete required are materially reduced over that of solid girders of the same span. Then, too, by molding the trusses on the ground and not in place, the cost of forms was reduced considerably.

BOWSTRING TRUSSES, VERA CRUZ STATION

Concrete bowstring trusses were used to support the concourse roof of the Railway Terminals Station at Vera Cruz, Mex., in 1910-11. These trusses, shown in Fig. 3, have a span of 41′ and are spaced 21′ 4″ o. c. The concrete used was of 1:2:3 mix. The thrust of the top chord at supports is taken up by steel shoes anchored to the bars of the lower chord. To avoid any apparent sag the lower chords were given a camber of 2″. Skylights in the roof between trusses provide for ventilation and additional light. The surface of all truss members are bush-hammered to improve the appearance.

The bowstring type of truss without diagonals was decided upon in this particular case because of the fact that the panel loads were practically equal and also because this type presents a more pleasing and lighter appearance than slab and



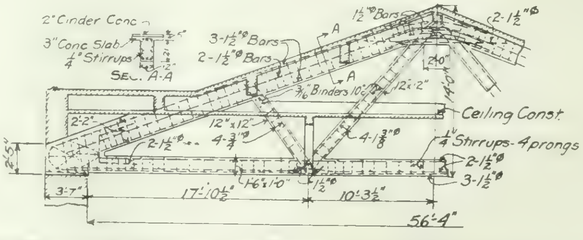


FIG. 2—DETAILS OF VISINTINI TRUSS, TEXTILE MACHINE WORKS, READING, PA.

FIG. 4—REINFORCED CONCRETE FINK TRUSS, ATLANTA UNION STATION

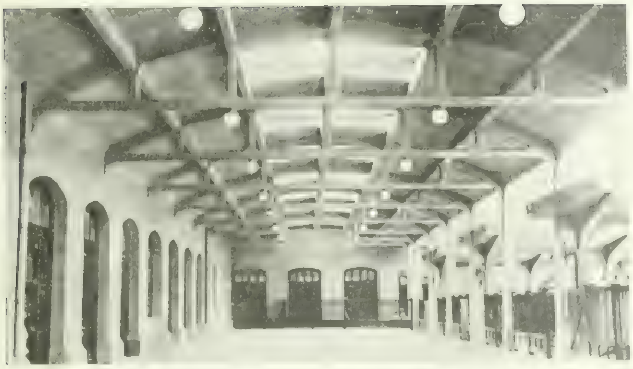
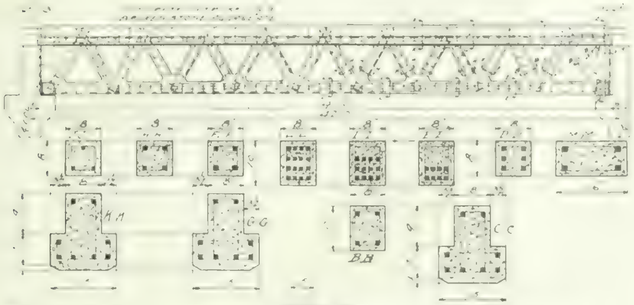
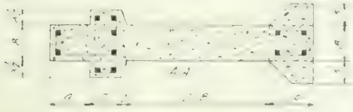


Fig. 3—Bowstring Trusses, Ry. Terminal Station, Vera Cruz, Mex.





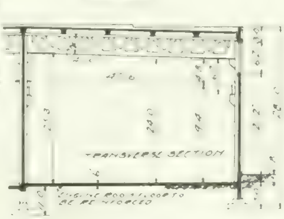


Fig. 5—Details of Concrete Trusses, Power House, Postex Cotton Co., Post City, Tex.

beam construction, in spite of the opposition to their use on account of expensive formwork and difficulty of exact theoretical analysis.

CONCRETE TRUSSES, ATLANTA TERMINAL STATION

Perhaps the first very extensive use of reinforced concrete roof trusses in the U. S. was in connection with the construction of the Atlanta Terminal Station, Atlanta, Ga., in 1904-5. This work included, among many other interesting features, four simple Fink trusses of 56-ft. 4-in. clear span and 14-ft. rise, five of 29-ft. 4-in. span with 7-ft. 9-in. rise, two king-post trusses of 29-ft. 4-in. clear span and five Vierendeel trusses of varying spans with sloping top chords.

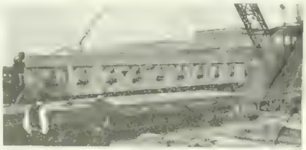
The long-span trusses over the main waiting room are spaced about 20-ft. 6-in. centers, with the top chord supporting roof purlins at panel points and half way between same (see Fig. 4). A concrete ceiling 2″ thick is carried on longitudinal beams framing into trusses 5′ above the bottom of the bottom chord, as shown in the accompanying detail.

The top chord, 2′ deep and 1′ wide, is reinforced with eight 1½-in. round bars in three layers and ¼-in. hoop stirrups at varying spacings, as shown in Fig. 4. At the peak, bars lap by the center about 4′ each way and the ends are wired to corresponding bars in the other half. The diagonals are 12″ x 12″, those in tension being reinforced with four 1⅜-in. bars and $^3/_{16}$ binders 10″ o. c., the rods being hooked around transverse bars placed between the main reinforcement of chords. Four ¾-in. bars with $^3/_{16}$-in. binders 10″ o. c. compose the reinforcement of the compression diagonals.

Eight 1½-in. bars placed in three rows comprise the reinforcement to take the tension in the lower chord, which is 1′ 6″ x 1′ in section. At the supports the bars for reinforcing chords are bent so as to extend for some distance into both the top and the bottom chords, where they splice with bars of the same size. The lower chord splices are made by a toggle-bar 2′ long, into which the ends of bars are hooked and then tightly wired. To distribute the truss reaction on walls a reinforced concrete bearing block about 3′ 6″ x 2′ 6″ and 10″ thick was placed under the ends. Where trusses framed into columns the connections were bracketed and reinforced with bent bars and stirrups.

The Fink trusses of 29-ft. 4-in. clear span support roof purlins at the top chord panel points and ceiling joists at the sixth points of lower chord. Both top and bottom chords are 16″ x 8″ in section, while the diagonals are 8″ x 8″. These trusses are reinforced in a manner similar to those just described except that the top chord reinforcement is so arranged over the supports as to reinforce the cantilevered and supporting the projecting eaves. At each end a reinforced concrete bearing block 13″ wide and 2′ long distributes the truss loads over the brick walls.

The king-post trusses of 29-ft. 4-in. span used to support the roof over the wings of the main building have a center height of about 6′ and support purlins and ceiling joists at the quarter points and center. The top chord is 8″ wide and 1′ 4″ deep below the roof slab, which is 4″ thick and is reinforced with two 1-in. bars in the top and the bottom tied together with hooped stirrups at varying spacings, as in beams, since the member was designed to act as a beam between panel points. The vertical tension member is 8″ x 8″,



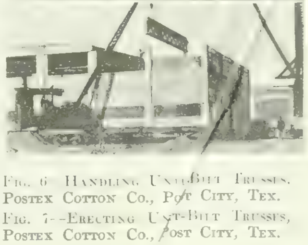


Fig. 6—Handling Unit-Bilt Trusses, Postex Cotton Co., Post City, Tex.
Fig. 7—Erecting Unit-Bilt Trusses, Postex Cotton Co., Post City, Tex.

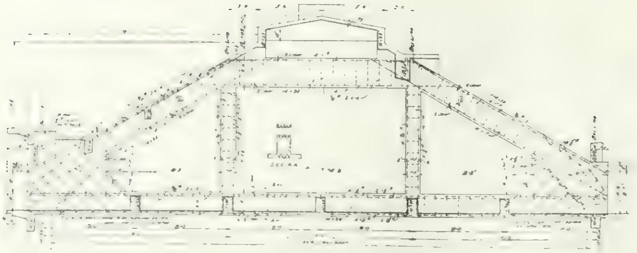


Fig. 8—Details of Queen Rod Trusses, Fulton Co. Court House, Atlanta, Ga.

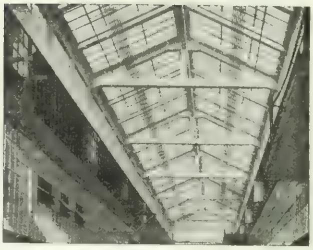


Fig. 10—Concrete Trusses, Ford Motor Co. Bldg., Chicago

reinforced with four ¾-in. rods tied with $\frac{3}{16}$-in. hoops, ends of bars being bent out into chord members for anchorage.

A 2½-in. ceiling slab is suspended from beams framing into the bottom chords, which are 16″ deep and 8″ wide. The stress is taken by five 1-in. bars, three in the bottom and two in the top, tied together with stirrups and carefully anchored by long bends into the top chord. The intersection of the chords at the ends is heavily reinforced with stirrups both vertically and horizontally.

The Vierendeel trusses over the midway support concrete purlins, carrying a 4-in. concrete roof slab, at alternate verticals, the purlins being spaced 7′ 2″ o. c. At the middle 12-in. x 12-in. verticals are used, while at ends they are 14″ x 12″ in section. The reinforcement consists of four vertical bars of varying size, depending on the span, with binders every 6″, the ends of verticals are bent at 45° into the chords for anchorage. The top chords are 12″ x 20″, reinforced top and bottom. The bottom chords, 12″ x 16″ in section, are reinforced with bars placed in three layers and bent up into the top chord at the ends of the trusses for anchorage.

The above described work was designed and built by the Ferro-Concrete Co., Baltimore. The drawing of truss is from Vol. 55, *Engineering News.*

VIERENDEEL TRUSSES, BALTIMORE GAS CO. POWER HOUSE

The roof of the power house of the Baltimore Gas Co. is supported by Vierendeel trusses with a span of 44′ and a height of 4′ at the center for a distance of two panels, from which the upper chord slopes down both ways to a height of 3′ 3″. The trusses are divided into six panels with rectangular openings between chords, except in the two end panels. The panel openings are about 6′ long and 2′ 3″ high.

The top chord is 16″ wide and 12″ deep, reinforced with three 1⅛-in. bars in the top and two 1-in. bars in the bottom, tied together with hoops. The lower or tension chord is 10″ x 10″, reinforced with four 1-in. bars in the bottom and two 1⅛-in. bars in the top securely tied with hoops at a fairly close spacing. The verticals, 12″ x 10″, are reinforced with four ¾-in. bars tied together with hoops or ties.

CONCRETE TRUSSES, POWER HOUSE, POSTEX COTTON CO.

A unique design of Visintini truss with 60° diagonals and no vertical members is exemplified by the precast trusses built to carry the roof of the power house for the Postex Cotton Co., Post City, Tex., in 1912.

The building is 143′ 4″ long and 84′ wide, divided into 16-ft. bays longitudinally and spans 42′ long transversely (see Fig. 5).

The trusses are 41′ long over all, with a total height of 4′ 10″, subdivided into nine panels 4′ 4″ long, as shown in Fig. 6. The top chord is of an inverted T-shape 16″ deep and 15″ wide at the bottom and at the top, to afford seats for the "inverted box" roof slab units. This chord is reinforced as a compression member, as shown in Fig. 5, the longitudinal bars being tied together with looped ties. The bottom or tension chord, 8″ wide and 10″ deep, is reinforced with ½-in. bars bent up at intervals where they are no longer required to care for the tensile stresses in the chord, into the diagonals (which slope away from the supports) and anchored in the top chord, as indicated in the details. All bars in these members are tied together with hoops. The compression members are all reinforced as columns with rods well anchored in top and bottom chords, and stayed with hoops. All diagonals are 8″ x 8″ in cross-section except the two compression diagonals at each end, which are 8″ wide and 10″ thick.

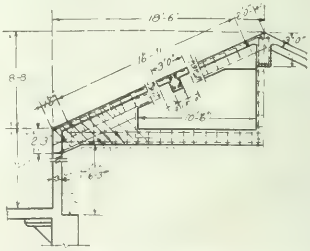


Fig. 11—Details of Concrete Trusses, Ford Motor Co. Bldg., Chicago

The trusses were designed for a live load of 25 lbs. per sq. ft. on the roof, the dead load of trusses, 15,780 lbs., and the dead load of roof deck, which amounts to about 50 lbs. per sq. ft. The unit stresses used in design were 20,000 lbs. per

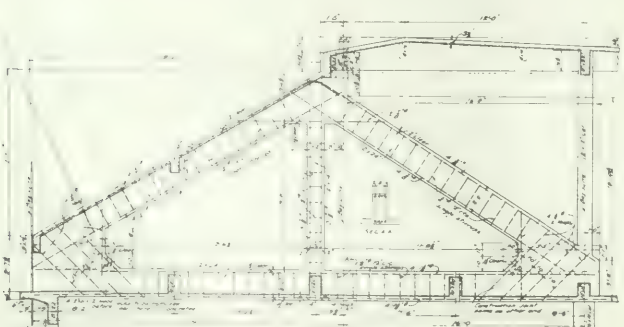


Fig. 9—Details of King-Post Trusses, Fulton Co. Court House, Atlanta, Ga.

sq. in. tension in steel and 600 lbs. per sq. in. compression in concrete.

These trusses, 16 in number, were cast in a central yard and after properly curing were loaded on flat cars by means of a locomotive crane (Fig. 6) hauled to the building and erected in place on columns previously set by means of a stiff-leg derrick and the locomotive crane, as shown in Fig. 7. The roof slab units were then placed on the ledges on top chords of trusses so arranged as to have the top of slabs 3″ above the top of trusses. The space between ends of the slab units and the top chord of trusses was then filled with the grout. This particular detail is covered by patents owned by the Unit Construction Co., St. Louis, which executed the work; the truss, however, is not patented.

TRUSSES IN ATLANTA, GA., COURTHOUSE

In the construction of the Fulton County Court House at Atlanta, Ga., built in 1911-12, concrete roof trusses were used to a considerable extent to support portions of the roof where columns were omitted and the outer edge was sloped to conform to the architectural motif. These trusses support the roof and the ninth floor ceiling and are placed 16′ o. c.

One of the main trusses of the double queen-rod type with a span of 48′ is shown in the accompanying detail (Fig. 8). It will be noted that chord members are 24″ x 14″ in section, the top chord being reinforced with four 1-in. x 1-in. bars in the top and the bottom, tied together by ⅜-in. rectangular ties at 12-in. spacing, while the bottom chord has six 1¼-in. x 1¼-in. bars at the top and the bottom, tied together in a similar manner. The bars in the tension chord are hooked at the ends to give a secure anchorage. The chords are connected at the ends by a heavy fillet with six rows of ⅝-in. x ⅝-in. U-stirrups placed diagonally in pairs to take care of the horizontal and the vertical shear. The verticals, 16″ x 14″ in section, are reinforced with eight ¾-in. x ¾-in. bars hooked around the top and the bottom chord reinforcement and tied together with ⅜-in. hoops at 12-in. spacing. The individual trusses are connected and braced by transverse beams supporting the roof slab and the suspended ceiling of the ninth story level with the bottom chords.

In another part of the building two king-post trusses of 34′ 7″ clear span and a rise of 14′ 8½″ were used. These were spaced 16′ o. c. The details of reinforcement and end framing are similar to those of the larger trusses and are clearly shown in the accompanying Fig. 9.

In constructing, the bottom chords of the trusses and the ceiling construction they support were first poured with dovetail construction joints formed at the ends, where the fillets join the top and the bottom chords, to aid in taking the thrust from the top chords.

The trusses were designed for a total live load of 50 lbs. per sq. ft. of roof and 60 lbs. per sq. ft. of ceiling, the total dead load of roof construction in accordance with the Joint Committee recommendations as to unit stresses. The trusses were planned so that the dead load would be as nearly as possible the same on both ends. The top and the bottom chord members were designed for both bending and direct stresses; the former, however, were comparatively small on account of the favorable arrangement of transverse beams.

The concrete roof construction was selected in preference to a steel frame, because of the irregularities of the roof, and the difficulty and expense of fireproofing it. Comparative bids on a structural steel building fireproofed with hollow tile block were $85,000 higher than for the reinforced concrete design, much of this difference no doubt being occasioned by the roof construction.

These trusses were designed by Wm. C. Spiker, C. E., Atlanta, Ga., to whom the writer is indebted for plans and data. Mr. Spiker has examined these trusses several times and reports that they show no signs of cracks in any parts.

TRUSSES IN FORD MOTOR CO., SERVICE BUILDINGS

Reinforced concrete trusses were used in the Chicago Service Building of the Ford Motor Co. (1913) to support the skylights over the interior craneway and the shipping court (see Fig. 10). The object of this court was to facilitate the handling and transfer of automobile parts and assembled cars from one floor to another or to the shipping platform by means of a traveling bridge crane.

The building, 234′ x 164′ in plan and six stories high, is of the Akme System of flat slab construction, with the shipping court 34′ wide and 205′ long in the middle of the building, extending from the second floor to the roof. At the roof line is a craneway of reinforced concrete girders of 28-ft. span designed for a 5-ton crane, covered by the monitor skylight of concrete truss construction. Below the crane girders are flat-slab balconies projecting out into the court from the various floors to receive freight and automobile parts picked up by the traveling crane at the second floor level, which in the court serves as a shipping and loading platform. The switch track enters the building on a through girder structure of reinforced concrete depressed 4′ below second floor level.

As a preliminary study as to the most economical design for the conditions to be met, general designs were made by the engineers[1] for (1) a monitor framing, consisting of reinforced concrete trusses carried on concrete side walls and (2) for steel trusses fireproofed with tile or concrete. Comparative estimates by the contractor showed the scheme of reinforced concrete construction to be the cheaper, notwithstanding the fact that the location made the problem of supporting the forms a difficult one.

The monitor framing consists of eight reinforced concrete king-post trusses with a clear span of 35′ 6″, spaced 28′ o. c. on reinforced concrete side walls and connected at the top by a continuous ridge girder supporting pairs of reinforced concrete rafters equally dividing the space between trusses.

The top chords of the trusses are of a T-section, web 18″ deep and 12″ thick, with a flange 3′ wide and 6″ thick. The main reinforcement consists of four 1-in. bars, two in the top and two in the bottom, tied together with ¼-in. ties 1′ o. c. The T is reinforced transversely by ⅜-in. x ⅜-in. bars 18″ o. c. in the top. The bottom chord, 12″ x 16″ in cross-section, is reinforced with six ⅞-in. mild steel bars anchored to end bearing plates to take the entire tension. These bars are tied together by ¼-in. ties 12″ o. c. At the connection of top and bottom chords is a heavy fillet reinforced with ⅝-in. x ⅝-in. stirrups, to provide for the end shear. The trusses are anchored to reinforced concrete piers 9″ thick x 3′ wide between windows at the sides of the monitor. The hanger at the center of the truss is 12″ x 12″, reinforced with six ⅝-in. x ⅝-in. bars hooked around the lower layer of steel in the bottom chord, and looped over the top bars in the ridge girder framing into the truss. The ridge girder connecting the trusses is 3′ deep and 12″ wide with wings 2′ wide on each side following the slope of the roof. The reinforcement consists of straight bars in the top and the bottom, with

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[1] Condron Co., Structural Engrs., Chicago

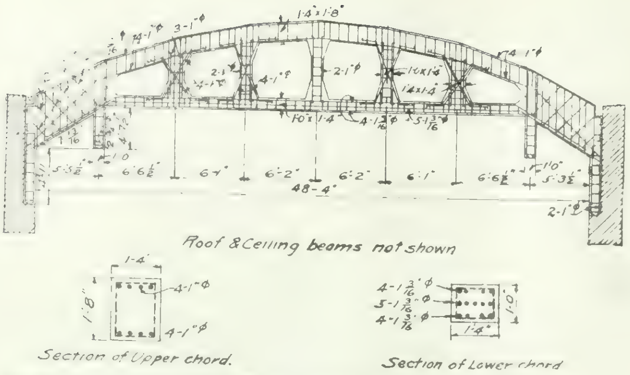


FIG. 12—DETAIL OF VIERENDEEL TRUSS, HEBREW SYNAGOGUE, POSEN, GERMANY

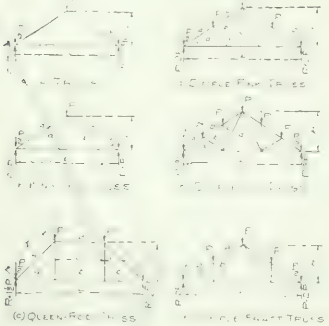
stirrups at the ends designed to take all shear in excess of 40 lbs. per sq. in. Rafters framing into the ridge girder at third points between trusses are 15″ deep, 10″ wide and have a flange 18″ wide x 6″ deep. The lower ends of rafters frame into the 18″ wide x 9-in. piers of side walls between windows which are 3′ 2″ high and 7′ 4″ long directly below skylights in roof. The details of trusses and monitor framing are shown in Fig. 11.

The concrete rafters divide the monitor roof into three spaces 7′ 4″ x 16′ 11″ long between trusses upon which the skylights are placed. A concrete curb 3″ x 3″ was placed on trusses and rafters around all openings to allow proper flashing over skylight frames.

The truss at the south end of the building is provided with stub bars and shelf angles at the ridge to give support for future ridge girders. At present these are covered with cinder concrete which can readily be removed when the building is extended.

Unit Loads and Stresses — The trusses and other monitor framing were designed for a live load of 30 lbs. per sq. ft. of monitor surface. All concrete used was of a 1:2:4 mixture, with crushed gravel as coarse aggregate. The reinforcing bars, except for those in the bottom chord tension member of the trusses, were cold twisted square bars, while plain rounds of medium steel were used in the bottom chord members. The allowable tension in these latter bars was 16,000 lbs. per sq. in., while 18,000 lbs. was allowed for the others. For direct compression in top chord of the truss combined with compression due to bending a maximum of 700 lbs. per sq. in. compression was allowed on the extreme fiber.

Construction of Monitor — The forms for all parts of the monitor, including side walls, trusses, rafters and ridge girders, were completed and all reinforcement fabricated and properly placed before any concrete was poured. The forms for the trusses and the rafters were support- upon wooden beams spanning between crane girders and braced by diagonal shoring from the sixth floor. Concrete work was carried on continuously, the sloping top chords of trusses and the rafters being run in closed forms, the top lagging being put in place as filling proceeded. An attempt was made to fill these forms through a hole in the peak, but they did not fill satisfactorily on account of the large amount of web reinforcing and the method just described was used instead. By using a sloppy mix and spading the concrete well when placing in the forms, an excellent finish was obtaind on all parts of the monitor framing.



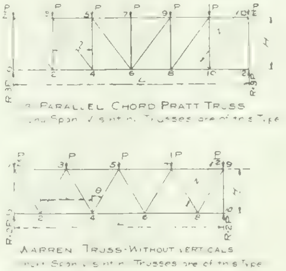


FIG. 13—DIAGRAMS OF "A," KING-POST, QUEEN ROD, FINK, FAN AND PRATT TRUSSES

FIG. 14—DIAGRAMS OF PARALLEL CHORD PRATT AND WARREN TRUSSES

Trusses of about the same span and of similar design were used to span the craneways of the Indianapolis, the Atlanta and the Cleveland building, of the Ford Motor Co. In constructing the trusses in the two former the formwork was supported on wooden latticed trusses, placed quite close together and spanning the craneway at the level of the top of the crane girders. No top forms were used on the top-chord beam boxes, the concrete being of a comparatively dry mix tamped in place and the top surface finished off as the work proceeded.

EUROPEAN EXAMPLES OF CONCRETE TRUSSES

In Europe concrete trusses are used quite extensively, but the common practice differs quite radically from the American in that trusses of the Vierendeel and Visintini types are used oftener than those of the forms commonly used for wood and steel construction. This is no doubt due to the fact that European engineers have given the matter of stresses in statically indeterminate structures much more attention than American engineers, who have for the most part been reluctant to use concrete structures other than those which are statically determinate. The present-day tendencies are toward the use of more complex types of concrete construction and the time is probably not far distant when the American engineer will not hesitate to design structures which now seem entirely too complicated and daring.

The writer's intention in giving descriptions of European trusses is to illustrate typical examples of different kinds rather than give an extensive resumé of the great number which have been built.

VIERENDEEL TRUSSES, POWER STATION, SO. HOLLAND ELECTRIC RY. CO., THE HAGUE, HOLLAND

Eight-panel Vierendeel trusses of 58′ 7″ clear span carried on concrete columns were used to support the roof slab of the power station of the So. Holland Electric Ry. Co. at The Hague, built in 1902. The trusses are 4′ 1½″ high over the two center panels and then pitch down toward each support on a slope of 1:20. All members are 14″ x 14″ in cross section, heavily reinforced with bars and hoops or ties. The verticals are spaced 6′ apart and are connected to the chords by heavy fillets.

TRUSSES IN ABATTOIR AT DRESDEN, GERMANY

The connecting hall of the Dresden abattoir is a building 65′ 7″ wide, with the pitched roof carried on concrete trusses spanning between side walls and spaced 16′ 5″ o. c. The roof slab is reinforced to span between purlins which frame into the top chord of trusses at panel points 8′ 1½″ apart. The trusses, 36 in number, have a center height of 8′ 7″, with the top chords sloped so as to give a depth of 4′ 1½″.[2]

They are a modification of the Visintini type in that the compression members instead of being vertical are inclined slightly toward the supports. The panel at each end is made solid to aid in resisting the shearing stresses, which are a maximum at those points. The top chord is 18½″ deep x 16″ wide. The compression diagonals have a cross-section of 10″ x 14″, with reinforcing bars in each corner tied together with hoops and well anchored into the chords. The tension diagonals are 6″ x 14″ in section, with bars anchored into chords, and are without hooping. The reinforcement of both the upper and the lower chords is tied together with hoops and the ends of the bars are anchored over supports by hooking and bending up the ends. The members were designed so that the stresses in steel did not exceed 14,200 lbs. per sq. in. (1,000 kg. per cm²). The maximum chord stress for dead load, snow, wind and load from monorail attached to the lower chord on one side amounted to 220,500 lbs. Although unsymmetrically loaded on account of the monorail the trusses were built symmetrically with respect to the center line for appearance's sake.

TRUSSES IN THE CATHOLIC CHURCH OF THE GARRISON AT KIEL, GERMANY

A most interesting type of concrete truss was used in the construction of the Garrison Catholic church at Kiel. The trusses, two in number, have a clear span of 72′ 2″

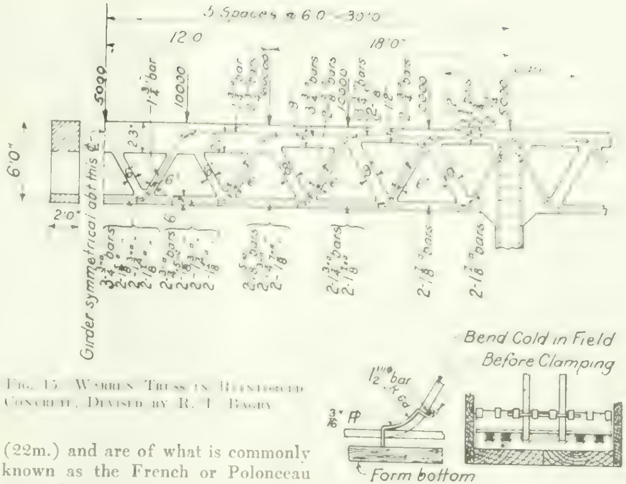


FIG. 15. WARREN TRUSS IN REINFORCED CONCRETE, DEVISED BY R. I. BAGBY

(22m.) and are of what is commonly known as the French or Polonceau type of truss, which is similar to the Fink truss, except that the bottom chord at the intermediate panel points is raised considerably above the level of the supports, in this case 7′ 3″ (2.2m). The trusses have a height of 22′ 11½″ (7m) between centers of members. The top chord is 1′ 8″ deep and 16″ wide and the lower chord 6″ deep and 16″ wide. The compression diagonals have the same section as the lower chord, while the tension diagonals are only 6″ x 6″.

The reinforcement of all members is tied together with hoops and well anchored at all intersections by generous bends and hooks. The diagonals are connected to chords by large fillets reinforced with hoops placed parallel to the edges. The trusses were designed for dead load plus a wind load of 30 lbs. per sq. ft. (150 kg. per m²) on the sloping roof surface.[3]

VIERENDEEL TRUSSES, HEBREW SYNAGOGUE, POSEN, GERMANY[4]

In the reconstruction of the Synagogue of the Hebrew Brotherhood of Posen, Germany, in 1912, reinforced concrete trusses of a very interesting design were used to carry the roof construction and the suspended galleries. These trusses, four in number, of the Vierendeel type, with the top chord broken at panel points to conform to the outline of roof surface, have a clear span of 48′ 4″ and a rise of 7′ 9″ and are spaced 21′ 6″ o. c. Each truss is divided into eight panels of about 6′ each by vertical members 16″ x 12″ in section at the middle with heavy filleted connections to the chords. The two end panels were made solid and a part of the fillets formed at the ends to give adequate section to resist the end shear. To reduce the unit bearing on the old walls to an amount considered safe, especially constructed bearing blocks 12″ wide and 3′ 5″ long were formed at the truss ends.

Details of reinforcement are shown in Fig. 12. It should be noted that the reinforcement for each member is bound together with hoops and that all bars are securely anchored into the intersecting members. The roof slab, 3¼″ thick, is supported on longitudinal beams framing into the upper chords of trusses at panel points. The ceiling slab is 6″ thick and is carried on the lower side of beams framing into the lower chords at panel points.

Concrete trusses were given preference in this particular case over those of steel because of the added safety provided by the former in case of fire with no appreciable difference in cost or rapidity of erection. The trusses were designed in accordance with the methods evolved by Podolsky. The stresses for combined flexure and direct stress are a maximum in the end panel where the total stress in both upper and lower chords is 366,000 lbs. The upper chord contains 310 sq. in. of concrete and 6.1 sq. in. of steel, so that the unit compressive stresses are 500 lbs. per sq. in. in concrete and 7,526 lbs. per sq. in. in the steel. The lower or tension chord contains about 14.25 sq. in. of steel, which is stressed to 14,130 lbs. per sq. in.

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[2] A drawing of these trusses was given in the Oct., 1912, issue of CONCRETE-CEMENT AGE, p. 38

[3] The data on the two last described installations were taken from *Handbuch für Eisenbetonbau*

[4] Abstracted from *Beton u. Eisen*, Jan. 8, 1914

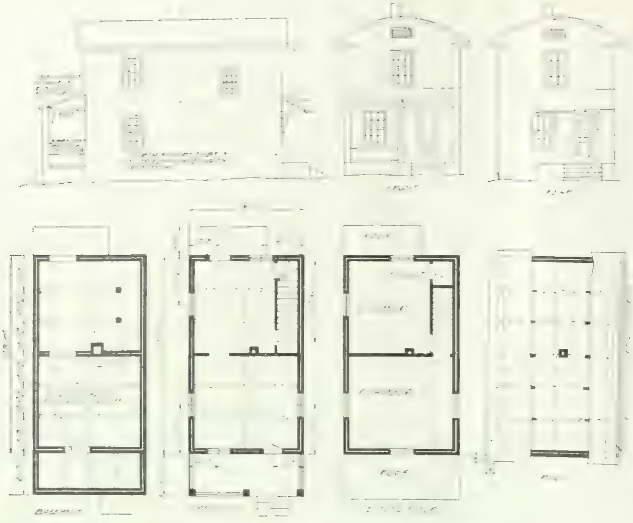

Fig. 1—Plans and Elevations of Low Cost Industrial House

Low Cost Houses For Industrial Operatives

By C. D. Gilbert

The problem of housing employees at industrial operations remote from large towns where large numbers of foreign laborers are employed is one that has been given much attention during recent years.

The house here described was designed by the author for a large coal mining company; it was intended to build a group of these houses, provided that concrete could be used economically. Investigation proved that in this instance, owing to the great distance which concrete materials must be transported, the concrete house was uneconomical as compared with other types but where concrete materials are available at reasonable cost it is believed that unusually comfortable and low-cost buildings can be constructed along the lines indicated. It is obvious that the methods described could be adapted to other floor plans providing all the buildings are to be alike.

DESIGN

Inspection of the plans will show that the houses consist of four rooms, the living room, kitchen with stairway, and two bedrooms on the second floor. Provision is made for electric lights and water is to be brought into the house. Careful consideration has been given to having the buildings perfectly insulated and models of sanitation. The concrete construction and the almost entire absence of trim will enable them to withstand the abuse to which houses of this character are subjected. They can be flushed out with a hose and thoroughly cleaned when necessary, without damage to any part of the structure. Serious fire would be impossible.

An arched roof is used which provides ventilated air space over the bedrooms and makes them comfortable in all seasons. This type of roof presents a better appearance than the steep pitched roof generally used on wood houses of this character. It is very simple to construct and no upkeep should be necessary.

CONSTRUCTION

The house is designed to rest upon poured concrete footings or trench walls. The floors are to be of reinforced concrete beam and slab construction and an air space is provided under the lower floor. The walls of the building are double and designed to be constructed with a hollow wall machine[1] although where it seems desirable double block construction can be used. Floors are designed to be cast by means of a series of unit cells or forms in the shape of inverted boxes supported on planks which form the beam bottoms. This construction is clearly shown at Fig. 2. Two sets of forms should be provided, one for each floor. The roof form consists of five sets of rafter forms, two sets of end cornice forms and two sets of forms for the cornice at the sides of the building. These side forms are supported by the walls and by the staging as illustrated at Fig. 2. The projection of the side cornice forms gives a bearing for the end forms which can be bolted against the concrete wall. The rafter forms act as trusses and support light curved panels on which the roof slab is poured. Cornice, rafter and roof slab should be poured as a monolith. The porch walls can be of the same construction as the house walls, and the floor slabs reinforced or placed on fill. Unit forms would be made for constructing the porches. The porch railing could probably be best worked out as a pre-cast slab. If a considerable number of houses are to be erected it would be desirable to construct two sets of floor and roof forms; this

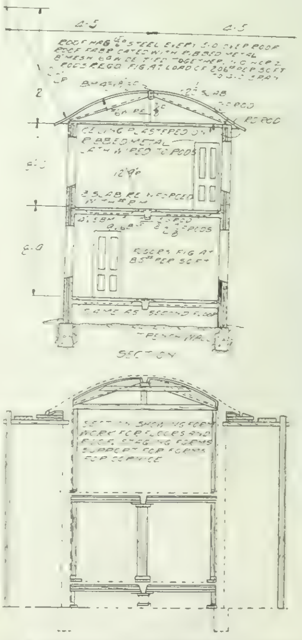

Fig. 2—Form and Reinforcing Diagram

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[1] Van Guilder Hollow Wall Co., Rochester, N. Y.

would enable these forms to be removed as fast as the concrete walls could be built with a machine. The surfaces left by the wall machines are rough and form a perfect key for plaster. No attempt would be made to have the structural walls waterproof but the walls would be given a heavy coat of stucco which would waterproof them for all practical purposes. The air space would provide exceptionally good insulation.

The interior walls would be finished one coat with a cement mortar continuously with the top surface of the floor. These walls could be given a coating of cement paint if desirable but this has not been figured in the estimate.

ESTIMATE OF COST

EXCAVATION

Excavation (trench)	10	cu yds.

FOUNDATION

9.77 cu. yds. concrete, 12 in. wall below grade	10	cu. yds.

ESTIMATED QUANTITIES OF CONCRETE

OUTER WALLS

1,716 sq. ft. 8 in. wall+55 sq. ft. for gables	44	cu yds.

PARTITIONS

Cross wall 14′ x 8.5′	83 cu. ft.	
Partition 14′ x 17′	79 cu. ft.	
	112 cu. ft.	
2 piers in cellar	7 cu. ft.	
Stair partitions 13′ x 17′	68 cu. ft.	
Total	187 cu. ft.	
	or	7.0 cu. yds.

FLOORS

2 floors	7.5 cu. yds.
Beams	1.5 cu. yds.

ROOF

Slab 20.5′ x 30′=615 sq. ft.	8.0 cu. yds.

PORCHES, ETC.

Front porch foundation	4.0	cu. yds.
Porch floor	1.0	"
Steps	1.0	"
Column and beams, porch columns, beams and roof	2.0	"
Balusters	.5	"
Stairs	1.0	"
Rear porch, ⅔ of front	6.0	"
Chimney	1.0	"
Total yardage	94.5	cu. yds.

Concrete, rough, 100 yds. @ $2.40	$240.00
Inside plaster (one coat), 312 yds. @ 20 cts.	62.40
Outside plaster	40.00
Reinforcing, as per plan[1]	60.00
Labor and mixer	166.00
Window and door frames and sash	40.00
Outside doors	8.00
Inside doors	15.00
Flue lining	4.00
Wiring	12.00
Stairs	20.00
Painting	10.00
Total cost of house	$677.40

DETAILED LABOR ESTIMATES FOR TWO HOUSES

14 das. operator @ $4.00	$ 56.00
14 das. 4 laborers @ $8.00	112.00
Labor for setting forms for floors and setting floors	150.00
14 das. for mixer @ $1.00	14.00
	$332.00
Labor cost per house	$166.00

MEMO

No allowance for staging lumber.
No allowance for floor and roof forms (which will cost about $150 to $200), to be divided among the houses built.
No allowance for investment in the Hollow Wall Machine.
No charge for superintendence.
Walls were figured solid, estimated on the basis of 100 yds., 4 yds. in excess of actual figures, nothing deducted for openings.

FIG. 3—DETAILS OF TRIM

Concrete material costs, based on sand and gravel per cu. yd	$1.00
Cement per bbl	1.40
	$2.40

INTERIOR TRIM

Inspection of the details will show that woodwork has been reduced to a minimum. Partitions could be of frame construction but preferably of concrete poured in unit forms or laid up of special block. The wood trim would consist merely of a quarter-round attached to the wood frame or even better a quarter-round metal trim[2] which is now obtainable.

Window frames are equally simple and no balances are provided for. If found desirable it would probably be more satisfactory and economical to use a spring balance than weights.

Reinforcing for the floors and roof is well shown at Fig. 3. The walls would be reinforced with ½-in. rods in the wall below and above window openings, these rods being carried entirely around the wall. No vertical reinforcing would be required. One-inch round rods are provided to take the thrust at each pair of rafters. These rods are tied to the center of the roof to prevent sagging and to them some type of ribbed expanded metal is wired and plastered, forming a suspended ceiling.

COST

Estimates were based on wholesale buying and labor at rural prices. They do not include lumber for staging or cost of floor and roof forms or the wall equipment. The set of forms for floors and roof could probably be built for about $200. This and the cost of the wall machines would be divided among the number of houses to be built. It is assumed that a small mixer would be available and not purchased for this special work. A charge of $1.00 per da. is made for the mixer. Superintendence and overhead are not included. In figuring concrete quantities no allowance is made for openings which should make good waste and shortage.

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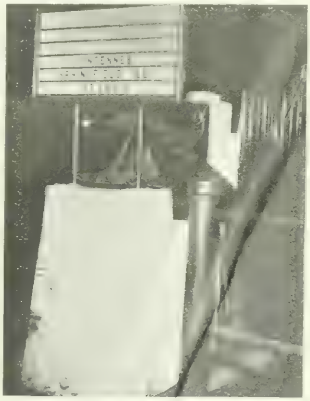
[1] This figure based on normal steel prices

[2] Carter Sheet Metal Co., Omaha, Neb.

An Effective Concrete Bumper Post

The concrete bumper post shown in the accompanying illustration was placed by Supt. Harry S. Johnson at the Grand Central Depot, Cincinnati. Bumper posts of a similar type, using a wood post, have been found effective but it seems that concrete construction will be permanent and even more substantial.

The post is 41″ high, 24″ x 24″ at the base and battered to 18″ x 18″ at the top. Two short sections of 80-lb. rail are placed in the post, while the edges are protected by angle irons. The top of the post is finished with an iron plate on which is set the casting to receive the ends of the rails and the cushions of wood and of rubber which assist in absorbing the shock.



CONCRETE BUMPER POST

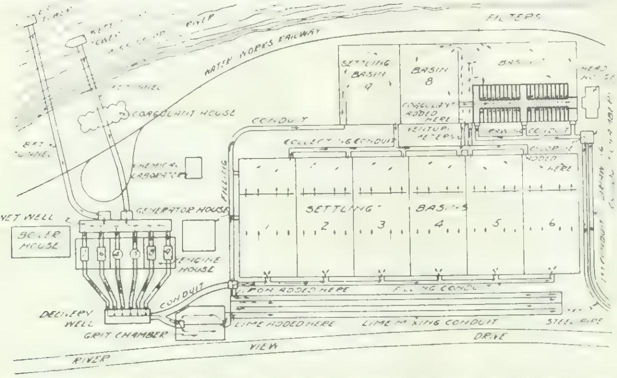


Fig. 1 Above the Completed Plant, Below Diagram Showing Layout of Water Purification Plant, St. Louis
Course of water shown by arrows

Construction of 160 Million Gallon Filter Plant at St. Louis

By John C. Pritchard[1]

Due to the rapid increase in the water consumption in the city of St. Louis, it has become necessary to increase the capacity of the purification system. After estimates as to the comparative costs of additional sedimentation basins and a filtration plant, to be used in connection with the present treatment, the latter was decided upon, both from the reason of economy and for the more uniformly satisfactory effluent obtained therefrom. In accordance with this decision, plans were prepared by the Water Dept., and contracts were let for the filter and filter equipment and for the superstructure to house the filters.

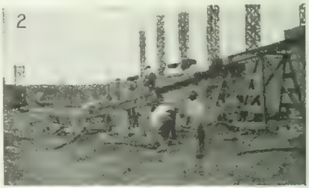
The plant is of the rapid filtration type and consists of 40 units, each having 1,400 sq. ft. of effective area and a normal capacity of 4,000,000 gals. in 24 hrs., giving a total capacity of 160,000,000 gals. The units are arranged in two rows, with the effluent conduit, pipe gallery and influent flume between the rows. The top of the influent flume and the tops of the filter boxes are at the same elevation, forming the operating floor. The plant is located in one of the sedimentation basins and is 700′ x 133′ over all, with a 50-ft. extension at the south end. The filter units are built over a series of groined arches, supported on groined inverts which, in turn, rest on the original basin bottom. The soil pressure amounts to about 1,200 lbs. per sq. ft., a little less than the pressure existing when the basin was filled with water.

CONSTRUCTION PLANT

The entire area of the plant was covered four times at four elevations, first with the inverts, then the groined arches, then the filter boxes and then the roof. The location of the plant inside the basin enabled the contractor to build an economical plant for handling the concrete.

The walls of the basin are of reinforced concrete of the buttress type. A pit was dug between two buttresses, approximately at the center of the plant, outside the west wall and down to the footing. A Lakewood mixer[2] and engine of 22 cu. ft. capacity was installed in the pit. An elevator tower, resting on the old footing and about 150′ high, was built directly in front of the mixers. On either side of the elevator tower auxiliary towers were built, 45′ o. c., carrying the main concrete chutes on a grade of 20%. The main chutes were of wood 14″ wide and 12″ deep, with triangular strips in the corners. Down-spouts were arranged at several auxiliary towers so that concrete could be taken off at any point desired and deposited directly in place. The steel chutes consisted of one 50-ft. trussed chute and several 30-ft. steel chutes, which were made to the contractors' designs. These were also 14″ x 12″, with rounded corners. The maximum distance traveled by the concrete was about 500′, it taking about 1 min. to travel that distance.

Sand, Gravel, Cement—Over the mixer, gravel and sand bins were constructed, supported on a framing of 12-in. x 12-in. timbers, with a floor of 2-in. x 10-in. planks set



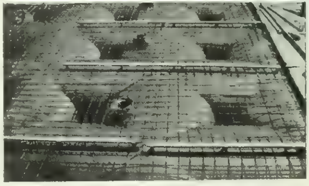


Fig. 2—Pouring Inverts

Fig. 3—Groined Arch Forms and Reinforcing Ready for Concrete

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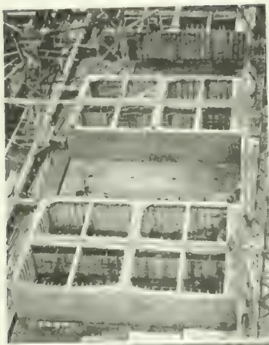
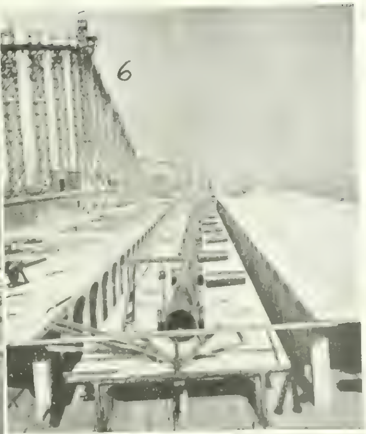
[1] Asst. Engr. in Chg. Const. of filters and head house, St. Louis

[2] Lakewood Engrg. Co., Cleveland





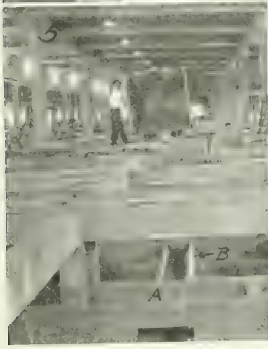


Fig. 4 View from Tower, Showing Filter Boxes

Fig. 5 Filter Boxes from Operating Floor, Showing Flume in Center of Box A, and Spreading Trough B

Fig. 6 General View, Showing Influent Conduit and Arched Floor Note main concrete chute running lengthwise of filters, with auxiliary chutes in the distance

Fig. 7 General View of Construction, Showing Arrangement of Plant

edgewise. The gravel bin has a capacity of 14 cars, the sand bin holds 10 cars of sand. Over the bins, a standard guage track, connecting with the main line of the Water Works Ry., was carried on a trestle with legs extending down through the mixer pit.

All of the sand and most of the gravel[3] was received in dump cars, which were placed over their respective bins and unloaded. The sand and the gravel were fed to a measuring hopper through spouts in the bottoms of the bins; cement was also fed through a spout from the cement shed located at the elevation of the basin coping, directly south of the mixer pit.

The contractor went very thoroughly into this matter of plant lay-out and several types were considered and discarded before the final lay-out was adopted. The total cost of the concrete plant was $3,428, of which $2,288 was for labor and $1,140 for matrial. This does not include the cost of the mixer, but includes the cost of the gravel and sand bins, erecting, maintaining and wrecking towers and chutes. The cost per yd. was 17 cts. and the cost per yd. of the towers alone was 10 cts.

The first concrete was poured July 17, 1913, in the groined inverts. These inverts are inverted segmental groined arches, 23″ thick at the column base or spring line and 8″ at the crown. Over the column center a wooden collar was erected 20″ x 20″ and 23″ above the floor. From each corner a wooden screed radiated, cut to the curve of the intersection of the inverted arches. The concrete was piled up under this collar and cut off with a straightedge across the screeds. After several hours, the screeds were removed, the holes filled with soft concrete and the whole invert shovel-finished (Fig. 2).

Columns and Arches—The columns and groined arches were next poured, the arch forms having been fabricated previously in the contractors' shop. These forms were framed with two diagonal ribs, cut to the curve of the intersection of the arches, two full ribs, and two short ribs between the diagonal ribs and the full ribs. The arches are elliptical in section, with a clear span of 9′ 4″ north and south, and 8′ 7″ east and west. The ribs were covered with 1-in. lagging on the sharp curve, 1-in. x 3-in. and 4-in. x 4-in. lagging being used on the flatter portion. Spaces of about 1″ were left between the lagging and the whole was form covered with No. 16-ga. galvanized iron.

In erecting these forms, the column forms, each having a 4-in. x

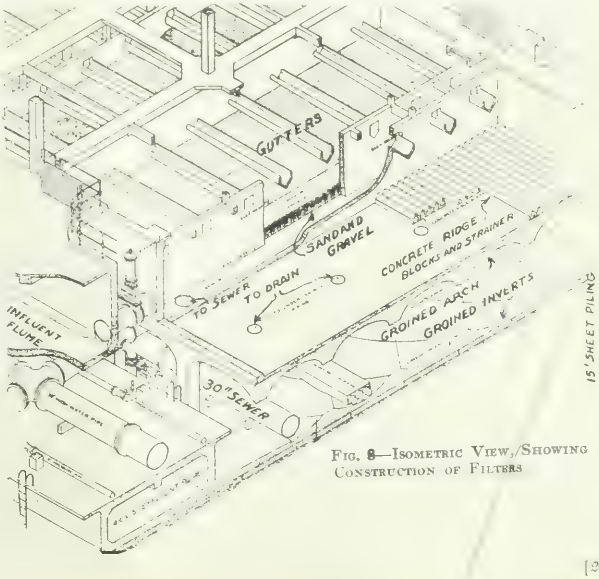


Fig. 8—Isometric View, Showing Construction of Filters

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[3] Universal Sand and Gravel Co., Pacific, Mo.

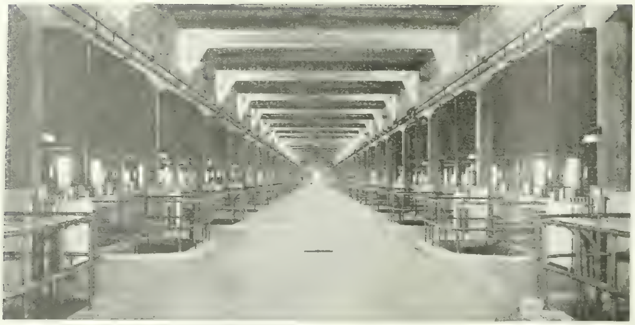


Fig. 9—Interior of Completed Filter Plant

4-in. belt at the top, were erected first, lined and leveled. Between the rows of column forms and running in both directions ribbon boards were erected, consisting of two 2 x 10's nailed on either side of a 4-in. x 4-in. post. The arch ribs were notched to fit the 4-in. x 4-in. collar on the column forms and to fit over the ribbon boards. The four sections of arch form framing on to one column form formed a rectangular panel 11′ x 10′ 3″. The diagonal ribs of adjoining segments were bolted together (Fig. 3). The tops of the concrete arches were brought up level to form a floor to receive the filter boxes, the concrete being 6″ thick at the crown and 2′ 6″ at the spring line. The arches were reinforced with 1½-in. bars 9″ o. c., running both ways, about 3″ below the flat top. In stripping these forms, which was usually done 4 das. after pouring, the bolts were removed, the ribbon boards taken down and the panel slid off the 4-in. x 4-in. collar and lifted down.

Filter Boxes—The filter boxes were erected on top of the arches (Fig. 4). These boxes were 33′ x 51′ 9″ out to out and 31′ 6″ x 50′ inside. The side and the back walls are 9″ thick; the front wall is 12″ thick. Longitudinally in the center of the box is a channel 2′ wide with 6-in. walls 7′ 3″ high above the 6-in. bottom of the box (A-Fig. 6). This channel receives the water from the influent flume and distributes it by means of 16 lateral gutters, eight on either side of the channel (B-Fig. 6). Each box was required by the specifications to be poured as a monolith. In pouring, a hopper was set up at the top of the box about in the center, with a chute from each side, leading to each corner of the box. The hopper received the concrete from the main chutes, and by using the small chutes alternately, the walls were brought up practically level. The bottom of the box was poured first, the concrete being banked up slightly against the sides to hold the walls. The interior wall forms were supported on 2-in. x 4-in. legs, which were removed the day after pouring and the holes filled with mortar. Each box contained 107 cu. yds. of concrete and required about 7 hrs. for pouring.

Flumes and Pipe Gallery—Between the two rows of filters are located the effluent conduit, the pipe gallery and the influent flume (Figs. 6, 7 and 8). The footing for the effluent conduit was poured at the same time as the groined inverts, the vertical steel for the side walls being set and the key left to key in the walls. The walls and top of the conduit are 12″ thick, the inside height being from 4′ 6″ to 6′, as the footing follows the slope of the old basin bottom. The conduit is 15′ wide in the clear and has a 12-in. x 28-in. beam in the center on 12-in. circular columns, to support the 36-in. wash water pipe. The top and the sides were poured together, the 700′ of conduit being poured in six sections.

The pipe gallery is between the effluent conduit and influent flume and is 4′ 6″ high. It contains the wash water pipe with connections every 33′ for the filters and two 6-in. pressure lines to operate the hydraulic valves.

The influent flume forms the roof of the pipe gallery. It has 12-in. side walls and a 12-in. bottom, supported on columns 11′ o. c., which rest on the walls of the effluent conduit. The roof slab of the flume is a 4-in. slab supported on beams. The method of pouring the flume was practically the same as for pouring the filter boxes, the bottom being poured first, and the walls carried up to within about 2′ of the top. It was not possible to pour the top the same day as the sides, as the roof beams could not be shored against the wet concrete. The influent flume contained about 42 cu. ft. of concrete per lin. ft., and the 780′ were poured in seven sections. The forms for both effluent conduit and influent flume were made from 1-in. lumber with 2-in. x 4-in. ribs 18″ o. c. The whole was covered with 16-ga. galvanized iron, oiled with paraffin oil immediately before use.

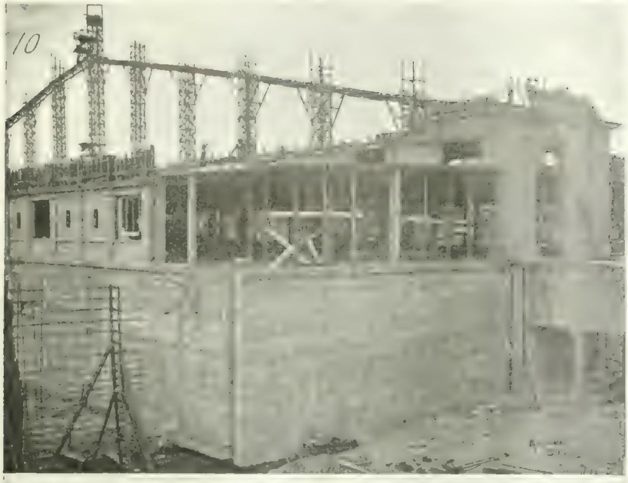
Distributing Gutters—The lateral distributing gutters are 14′ in length and were cast of concrete 3″ thick. For proper operation of the filters it was essential that the edges of these gutters, over which the water flows when washing the filters, should be absolutely true and level. In order to accomplish this, the gutters were cast in an invrted position, on a concrete slab which had been very carefully leveled. The forms for the gutters were tin covered, with the nails countersunk, soldered and scraped. The results have been very satisfactory.

Form Ties—The specifications provided that no wire nor ties should be used in form work which would project beyond the surface of the concrete. A simple form of wall tie was used, made by blacksmiths on the job. The tie consisted of a loop of ⅛-in. x 1½-in. strap iron, the loop having square ends with the ends of the strap iron riveted together. The ends of the loop were punched to receive a ½-in. bolt. The ties were made in such lengths that there would be about 2″ of concrete between the ends of the tie and the surface of the concrete. Bolts were inserted through the forms, the heads bearing on bolt rails consisting of two 2 x 4's with ½-in. space between them. The bolts were put through the tie and screwed into nuts which were held by the square ends of the loop and tightened against spreaders, which were removed immediately before pouring. The day after pouring the bolts were loosened, unscrewed from the nut and pulled out, the bolt hole being plugged with mortar.

CONCRETE DATA

The proportions of the concrete for the groined inverts, arches and walls were 1 part cement, 2½ sand and 5 of gravel For all reinforced concrete, the proportions were approximately 1:2:4. In the filter boxes about 5 lbs. of hydrated lime were added for each sack of cement. No leakage has appeared through the sides or bottom, showing that the hydrated lime has acted as a successful waterproofing.

The best day's run on inverts was 160 yds., on groined arches 220 yds. The largest quantity in any one day



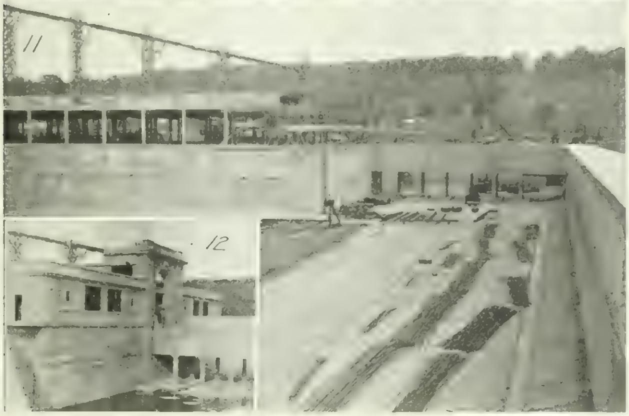


Fig. 10—North Main Entrance, Showing Architectural Treatment and Roof Construction

Fig. 11—General View from Basin 7

Fig. 12—North End Near Completion

was 230 yds. in the effluent conduit footing. Thirty-eight filter boxes were poured between Oct. 21 and Dec. 13, the last 24 boxes being poured in 27 consecutive days. Each box contains 107 cu. yds.

COSTS

The substructure contract was for $235,000 and the equipment contracts amount to $398,000. Costs are summarized as follows:

Inverts, 2,118 cu. yds.	$ 7.00	per	cu. yd.
Piers, vaults and walls, 3,522 cu. yds.	9.80	"	"
Reinforced concrete, 9,960 cu. yds.	9.68	"	"
Gutters, 284 cu. yds.	29.00	"	"

HOW THE WATER IS PURIFIED

A brief description of the operation of the plant will make the construction more clear and may be understood by reference to Figs. 1, 8 and 9.

The treatment the water receives between the time it is taken from the river and the time it leaves the filter plant for the city is divided into a number of stages, which may be separated as follows:

1. Lifted from 27′ to 65′, depending on the stage of the river. 2. Freed from heavier sand and sediment. 3. Treated with lime and softened. 4. Treated with sulphate of iron and a coagulant to remove most of the turbidity, and passes into settling basins, where from 95% to 99% of sediment and bacteria are deposited. 5. Treated with sulphate of alumina to remove color and provide a coagulation satisfactory for filtration. 6. Filtered through sand, as a finishing process to remove all the coagulation and sediment and most of the remaining color and bacteria. 7. Treated with liquid chloride to kill any bacteria that may pass through the filters.

The water, after treatment, as it leaves the filter plant will be sparkling, clear and free from bacteria of any kind that might produce disease.

METHODS OF OPERATION

The water, drawn from the river at the intake towers, will pass through tunnels to the screen chambers and wet well and to the masonry delivery well. Leaving the well, it will pass to the grit chamber, a reinforced concrete basin, 96′ long, 65′ wide and from 15′ to 24′ deep designed to reduce the velocity of flow to permit the deposit of the heavier matter in suspension, principally sand, before any treatment with chemical.

Leaving the grit chamber, the water flows through a reinforced concrete passage to the lime-mixing conduit, receiving the charge of lime as it enters the conduit. The lime-mixing conduit is a reinforced concrete box, 2,382′ long, 32′ 1″ wide and 12′ 6″ high, divided longitudinally into four compartments, each 7′ wide and 11′ high.

Leaving the conduit the softened water recives the charge of coagulant, sulphate of iron in solution, and enters the filling conduit through which it passes to the sedimentation basins.

The basins have a total working capacity, with one empty for cleaning, of 172,000,000 gals.

From the collecting conduit the water passes through the Venturi meters into the coagulation chamber, receiving the secondary charge of coagulant, sulphate of alumina, in solution just after it passes the throats of the meters and before it enters the chamber.

The coagulated water flows through the coagulation chamber, Basin 7½, and enters the secondary sedimentation Basins 7 and 8, through stop plank openings. It will remain in the coagulation chamber about 1 hr. and in the basins about 9 hrs. before entering the flume leading to the filters.

Leaving the basins, the settled water enters the concrete influent flume which extends the full length of the filters and from this flume is drawn on to any or all of the 40 filter units.

Entering the filter unit by the gutters at the center of the box, the water rises and flows on to the sand on either side of the central gutters. The sand layer, 30″ deep, rests on a 12-in. bed of gravel, which is in turn supported by the strainer system. The water passes down through the sand and gravel through the $\frac{1}{16}$-in. holes in the bronze strainer plates to the concrete passages under the plates to the 10-in. openings connected to the cast iron under-drain piping, which may be seen in place under the filters, supported from the arches (Fig. 8). This piping delivers the water to the concrete clear-water conduit under the raw-water conduit, which connects to the old drawing conduit at three points and delivers the water to the drawing conduit chamber, where a small charge of chlorine is added to kill any bacteria that may have come through the sand. From this chamber it enters the main conduit, from which it is drawn into the mains.

Filtering is continued until the dirt, coagulant, etc., collect in and on the sand to such an extent as to prevent the desired quantity of water from passing through without requiring high differences in head that might open up holes through the sand bed and permit the passage of muddy water. The filter must then be taken out of service and cleaned. This is done by reversing the flow; that is, passing filtered water, under pressure, through the cast iron under drains, the concrete passages under the strainers and the holes in the bronze strainer plates, up through the gravel and sand at a high velocity, so that the dirt, coagulant and bacteria are washed out of the sand and carried with the water into the V-shaped concrete troughs that discharge into the central gutter, which now discharges into the sewer, carrying the muddy water back to the river.

SUPERSTRUCTURE, CHAIN OF ROCK FILTERS

The superstructure or filter house over the filters and operating floor was designed after the filter contract had been in progress for several months. This building is an all-concrete structure, the roof being supported on a system of columns and pilasters resting on the filter box walls. The building is 700′ long, 133′ wide and 11′ high at the outside, the roof rising with a pitch of ½″ to the ft., toward a monitor over the operating floor, which is 6′ high and about 28′ wide.

The roof system consists of four main girders running longitudinally with the building, supported on columns 33′ o. c., this dimension being the out to out width of a filter box (Fig. 10). These girders carry the roof beams, which are 16′ 6″ o. c. and about 26′ in span, the outer end being carried on pilasters which were later incorporated in the outer walls. These roof beams carry the roof, which is an arched slab, 3″ thick at the crown and 6″ at the spring line. The north and south walls are the only bearing walls. The entire roof was poured before the walls were begun, the north and south end spans being carried on shores and the bearing walls afterwards poured around them.

WALLS

The exterior walls are of poured concrete. As the building is 700′ long and only 11′ high, it was necessary for architectural reasons to break the surface with frequent vertical lines. This was accomplished by means of rusticated pilasters about 11′ o. c., 3′ 8″ wide and 4″ deep. Above the roof was a parapet or fire wall about 30″ high, making the total wall height about 13′ 6″.

The specifications provided for alternate methods for constructing these walls. Permission was given to construct them either by a unit system, pouring the wall slabs on the ground and erecting them afterward, or to pour them against plastered forms, these latter being specified to secure the smoothness of surface necessary for the architectural features. Also the architectural work was so arranged that each day's run could be stopped on a horizontal or a vertical feature line, thus eliminating unsightly joints.

This contract was let to the contractors for the substructure. As it was not possible to erect the superstructure till the substructure was practically complete, no work was done until Mar., 1914. However, in the winter several experimental panels were constructed, with the result that the contractor was given permission to use canvas-covered forms, the surface obtained by the use of such forms being in every way superior to that produced by plastered forms and strongly resembling Bedford stone in texture.

SPECIAL FORMS DEVELOPED TO SECURE PLEASING SURFACE

In May, 1914, after the roof was finished, a section of wall form was erected on the monitor, to work the kinks out of this type of form where it would not be visible except at a distance. Tongue and groove lumber was used, covered with canvas. The cornice forms were not canvas-covered, but were painted with white lead and sanded with white sand. These forms gave an excellent surface, but every joint between the boards showed in the concrete, which was not permissible. A series of experimental panels was then erected on the monitor. Combinations of canvas on building paper, the latter being stuck to the lumber with hot pitch, canvas on asbestos paper treated in the same manner, and canvas on board forms whose joints were filled with plaster of paris were tried, but none of them proved satisfactory. Finally a combination of pitch, asbestos paper, beaver board and canvas was tried, proved thoroughly satisfactory and was used throughout the remainder of the building. It was found possible to use the beaver board as many as eight times, but it was necessary to renew the canvas each time the panel was used. The forms as finally used for the exterior consisted of 2-in. x 6-in. verticals sheeted with 1-in. lumber. This was covered with a layer if beaver board and then a layer of asbestos paper and finally a layer of tightly stretched canvas. The cornice forms were not covered.

Much credit must be given to Supt. Herman Bankes for developing and erecting these forms.

Concrete was poured in the forms by means of a long, narrow chute, made by nailing sheet iron on either side of two 4 x 4's. The concrete was handled from the roof by the same plant that was used for the substructure. The chutes were let down into the form, so there was no chance for the concrete to drop and separate. The walls were 8″ thick, with an 11-in. base course. The interior wall form was a plain form, and was brought up with the concrete. A day's pouring was always stopped at a vertical and horizontal line.

ROOF

The concrete roof was in place about 4 mos. before any roofing material was placed upon it and proved fairly watertight, though a few slight leaks developed. One expansion joint was provided in the roof and the walls, at the center of the building. Careful measurement over two brass plugs set in the roof for this purpose showed a difference of about ⅜″ in 300′ for a difference in temperature of 34° F.

ENTRANCE

The monitor at the north end and extending about 16′ to the south is about 5′ higher than the remainder of the monitor, to accommodate the main entrance door, which is about 12′ wide with a semi-circular arch at the top, containing a large ornamental keystone. This keystone was first modeled in clay, then a plaster form was made and the keystone cast, cured and set in place before the arch was poured. It was also necessary to cast a series of dentils over the main door and also the water spouts in the monitor. For the dentils and the water spouts sand molds were used.

A large window and two small windows are provided opposite each filter box. Windows 33′ o. c. are also provided in the monitor. Steel sash were used throughout. Six light fixtures are provided over each filter box, a two-light bracket on each column along the operating floor and a line of lights along the center of the operating floor. All electric conduit is embedded in the concrete work.

Heating is provided under another contract, and will be furnished from boilers located in the head house. The design of the heating system was complicated by the presence of a large area of constantly changing water.

PERSONNEL

The work was done under the general direction of Edward E. Wall, M. Am. Soc. C. E., Water Commr., and Gurdon G. Black, M. Am. Soc. C. E., Engr. in Chg. of the Supply and Purifying Division, with the writer in immediate charge in the field. The McCormack-Combs Const. Co., was the contractor for the substructure, the Pittsburgh Filter Mfg. Co. furnishing the equipment. The plant has recently been put in operation.

Aggregate Survey in South Dakota

At the suggestion of many of the engineers and contractors over the state of South Dakota, the experimental department of the South Dakota State College at Brookings has taken up the work of ascertaining the value of the materials derived from the gravel deposits throughout the state with reference to the desirability of the material for use in concrete construction, which is still in its infancy in that state. Reports received from time to time at the experimental department indicated that many gravel deposits contained material unfit for concrete construction and revealed the necessity of careful tests so that some partciular aggregate might be balanced by proper mixtures or by the addition of material from another source. This information was not obtained by the contractors in their regular work and could be ascertained only through scientific experiments.

Within the past year over 1,500 tests have been made of local material by the experimental department under the supervision of Robertson Cook, M. E., professor of experimental engineering. The materials have been subjected to the following tests:

1. A careful preliminary examination to determine the chief characteristics of the material.

2. A washing test; in this test 3″ of the material was poured into a quart Mason jar; water was added until the jar was nearly full and the cap screwed on. The jar was then violently shaken for 2 min. and was allowed to stand for 5 min. At the end of this time the height of the layer of dirt or fine material on top of the coarse material was measured. This divided by the total height of the material in the jar gave a result which for lack of a better term is called "per cent of dirt."

3. A sieve analysis was made to determine the percentages of the various sized grains. Sieves having openings of ¾″, ½″, ⅜″ and the smaller ones with openings of 4, 10, 20, 30, 60 and 100 meshes per lin. in. were used.

4. Standard tensile test specimens or briquettes were made up in proportions of 1 part cement and 3 parts sand. As used in all this work the word "sand" means that part of the material which passes a sieve having four meshes per in. and the word "gravel" that part of the material which will not pass through such a sieve. Specimens were tested at the end of 28 das. and others at the end of 56 das. after being made.

5. Two-in. cubes were made in proportions of 1 part cement, 2 parts sand and 3 parts gravel. Parts are all taken by weight.

6. Four-in. cubes were made of some of the samples using the proportions of 1 part of cement and 5 parts of the material as received.

7. The specific gravity was determined.

8. The percent of voids was determined.

The graphical method is used in reporting the results in most of cases, so that the comparative characteristics of the materials may be determined at a glance.

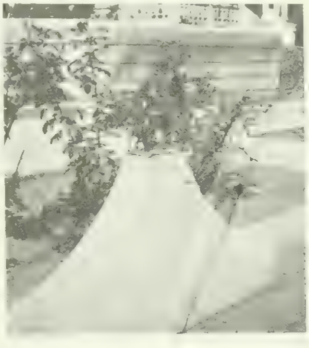
The following is a report made on samples submitted from one locality which produces sand used extensively throughout the vicinity adjacent to Watertown, S. D.:

> The tests indicate the specimens to be high-grade concrete materials. The pit when tested in 4-in. cubes made up of 1 part cement to 5 parts gravel gave a crushing strength of 1,740 lbs. per sq. in. at the end of 60 das. The sieve analysis showed that this specimen contains much too great an excess of fine material for the best results. A mixture was made of 1 part cement, 2 parts of pit-run and 3 parts coarse gravel; these cubes gave a crushing strength of 3,630 lbs. per sq. in. at 60 das., showing the great gain in strength when a coarse mixture is used. It should be a source of satisfaction to every concrete man in your vicinity that such excellent material can be obtained and in the various sizes so that a concrete of almost any desired strength can be obtained by intelligent proportioning.

The Curbing Hitching Post

A resident of Santa Ana, Cal., has presented a novelty which has been termed "the curbing hitching post." And it is just what its name implies, too, for it is a post which has been combined with the curbing which runs along the front of this resident's property. It was built at the same time as the curbing and out of the same batch of concrete. The usual place for the hitching post is the parkway, and this novel feature was the direct outcome of the desire of this property owner not to have his parkway obstructed in any way. He wanted flowers in the parkway, and nothing else.

This post is 2′ in height and 3′ 6″ in width at the point where it connects with the curbing, or rather, where it reaches the curbing level. It is, like the curbing, 8″ thick at its base, but as it proceeds upward it gradually tapers, until at the top it is but 6″ thick. Upon the top rests a sheet iron plate, through which the ends of a round iron loop has been passed, these ends continuing about 12″ down into the concrete. Both the post and the curbing are made of a mixture of 1 part of cement, 2 parts of sand and 4 parts of gravel.



CURBING HITCHING POST

The Use of Stucco as a Means of Modernizing Old Buildings

The popularity of the stucco house suggests a large field for this material in the renovation and modernizing of the old house.

By calling attention to the advantages of stucco through advertising, exhibits and by the use of circulars and letters. an interest can often be aroused that can be developed into profitable work.

There are thousands of frame houses requiring frequent painting and repairs which now appear unfavorably when compared with more modern buildings. These buildings can be modernized at a comparatively small cost.

In securing this work use can be made of printed matter furnished by manufacturers of metal lath and special stucco. The literature contains illustrations that will give the prospect a good idea of the appearance of his improvements when complete. Call attention to attractive stucco buildings in the vicinity.

When the work is secured see that it is planned and executed in a way that will make it a powerful selling argument with the next prospect. Not only individual owners but also real estate men and the larger property owners should be approached and shown that the money spent in modernizing property can often be made to move a "sticker" or to secure a good price for a property considered undesirable.

PLANNING THE WORK

No attempt to carry out work of this kind for residences or for any but the most severe type of business buildings should be made without competent architectural advice. The money spent for such service will be repaid many times in the value of the finished structure. While this statement holds true for any remodeling work it is particularly true with stucco in concrete construction. The beauty of the work lies largely in correct lines and proportions. It is a material to be used in broad surfaces and massive effects.

Ornamental details must be designed and executed with care on the part of the workman, and trained intelligence by the designer.

The remodeler must often use exceptional skill as the lines of his building are already determined and he must design a general treatment and details that will emphasize good proportions and minimize so far as possible unlovely lines.

Often additions are to be made to the building, such as sun parlors and sleeping porches. These must be so treated, if possible, as to be in harmony with the building as a whole.

PRELIMINARY WORK

If the weather boards are in fairly good condition they need not be removed. Heavy waterproof paper is tacked over the building and then furring strips, preferably of metal, are applied on 12-in. centers. Instead of furring strips, furring posts[1] or some type of crimped or

It is necessary to build out window and door frames to receive the stucco. The most common way of doing this is to apply a molding of the proper thickness to the old frame the molding acting as a ground for the plasterers. The appearance is best when the molding allows only about 2″ of the old frame to show.

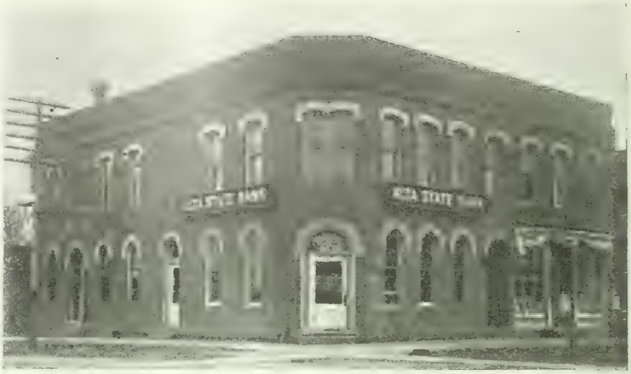


FIG. 1—ALTA STATE BANK BEFORE REMODELING

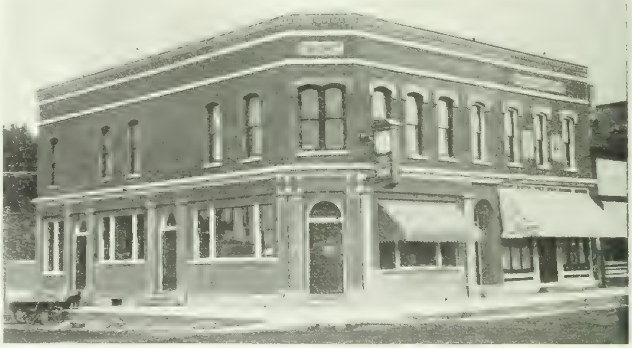


FIG. 2—STUCCO FINISH EFFECTS GREAT IMPROVEMENT

The water table line will need careful attention and the best construction is decided by circumstances. It is not generally best to carry plaster on metal lath close to the ground. If this is to be done see that the entire space back of the lath is filled and have the mortar not less than 2″ thick.

Often the old underpinning will be of a good quality of stone and need not be covered. In this case, the metal is usually sprung out to form a water table. It is well to use a temporary strip under the table as a form and ground, and to drive spikes into the wood sill to anchor the water table securely. One or two light rods fasteed to the lath at this point will help to prevent cracks.

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[1] Wagner-Behm Co., Chicago

CORNICE OR FINISH DETAILS

All alterations to porches, cornices, etc., should be complete before any stucco is applied. All cornices carrying ornament of the "gingerbread" type should be replaced with plain substantial members and moldings. The metal lath and stucco may either go up back of wood cornices and be given two coats at this point before the wood members of the cornice are applied or the soffit can consist of stucco and the fascia be metal covered. This construction is a great prortection against fire from adjoining buildings.

STAGING

Staging is a considerable item in stucco work. It should be substantial and safe and at the same time use no needless material, nor should it consume much time in erection.

Stages should be about 6′ 6″ apart so that all parts of the work can be easily reached. Probably the most used stage consists of poles and ledgers with bearers to the windows carrying the staging plank. A simple and in some localities a commonly used stage is constructed of single poles with cross-ledgers nailed at staging heights and braced. These carry a plank on each side of the pole and can usually be leaned against the cornice and tied to the windows. This stage has the advantages of requiring less lumber and leaving the wall free of all obstructions. The poles can be made up on the ground and brought to line on fairly level ground or easily spliced out on an uneven surface.

A swing scaffold is not generally used but some masons making a specialty of stucco have used with great satisfaction a heavy scaffold similar to a painter's stage. In use the scaffold is tied in to the building to enable the mason to get the proper push against the wall.

Workmen who are unaccustomed to the swing are usually not in favor of it.

MIXING STUCCO

The specifications of the Am. Concrete Inst. which have been adopted after extensive investigation read in part:[3]

PREPARATION OF MORTAR

Mixing—The ingredients of the mortar shall be thoroughly mixed to a uniform color, sufficient water added to obtain the desired consistency, and the mixing shall continue until the cement and lime are uniformly distributed and the mass is uniform in color and homogeneous.

The hair or fiber shall be added during the process of wet mixing.

Measuring Proportions—Methods of measurement of the proportions of the various ingredients, including the water, shall be used which will secure separate uniform measurements at all times. All proportions stated are by volume. A barrel of cement shall be assumed to contain 4 cu. ft. Lime when used shall be measured in the form of putty. Hydrated lime shall be made into putty before being measured.

Quantity—There shall not be mixed at one time more mortar than will be used within one hour. Mortar which has begun to stiffen or take on its initial set shall not be used.

Hand Mixing—The mixing shall be done on a watertight platform and the materials shall be turned until they are homogeneous in appearance and color.

Consistency—The materials shall be mixed so as to provide sufficient water to insure a proper bonding and a dense mortar free from voids.

Retempering—Retempering mortar, i. e., remixing with water after it has partially set, shall not be allowed.

MORTAR COATS

..*Plaster*—(a)[4] The *first coat* shall contain not more than 2½ parts of sand to 1 part of Portland cement by volume If lime putty is added, it shall not be in excess of ⅓ of the volume of cement. Hair or fiber may be added in sufficient quantity to bond the mortar.

[5]The *first coat* shall contain not more than 2½ parts of sand to 1 part of Portland cement by volume. If lime putty is added it shall not be in excess of ⅓ of the volume of cement. No hair, fiber or similar material of any kind or in any quantity shall be added to the mortar.

For *second coat*, the proportion of sand to cement shall not be greater than 2½ to 1 by volume, nor shall more than ⅓ part of lime putty be added.

For *third coat*, the proportion of sand to cement shall not be less than 2 to 1 nor more than 2½ to 1, by volume, nor shall more than ⅓ part of lime putty be added.

Application—The plastering should be carried on continuously in one general direction, without allowing the plaster to dry at the edge. If it is impossible to work the full width of the wall at one time, the joint should be at some natural division of the surface, such as a window or a door.

Metal Lath—(a) The first coat shall be applied to the outside of the lath and pushed through sufficiently to give a good key. Over the faces of the studs the plaster shall be forced well through the lath in order to fill entirely the space between the lath and the stud. The backing coat shall be applied to the back of the lath and shall be thoroughly troweled so that the lath shall be entirely covered. The final coat shall be applied to the face of the first coat.

(b) The first coat shall be applied to the lath and thoroughly pushed through against the inside waterproofing so as completely to embed the metal of the lath on both sides. Special care shall be taken to fill all voids around furring strips and where laths lap.

Brick, Tile or Concrete Block Surfaces—The first coat shall be forcibly and thoroughly troweled into the depressions of the previously saturated surface so as to make a firm bond. Care shall be taken to insure the complete filling by the mortar of all crevices and pores.

The intermediate and the final coat shall be applied in order and well troweled on to insure good contact with previous coats.

Roughing—Soon after applying and before the initial set has taken place, the surface of the coats which are to receive succeeding coats shall be roughened with a saw-toothed paddle or other suitable device.

Dampening — Before applying mortar the surface of the preceding coat shall be thoroughly wetted to prevent absorption of water from the fresh mortar.

Thickness of Coat—(a) The first coat shall be at least ⅜″ thick over the face of the lath and project through behind the lath about ⅜″. The backing coat shall increase the thickness behind the lath to not less than ⅝″. The final coat shall be not less than ⅜″ thick.

(b) The first coat shall have a minimum thickness over the lath at any point of not less than ¼″. The intermediate coat shall have a thickness of not less than ¼″ or more than ⅜″. The final coat shall have a thickness of ¼″ when placed over an intermediate coat, or of ⅜″ when placed dircetly on the scratch coat.

Drying Out—The final coat shall not be permitted to dry out rapidly and adequate precaution shall be taken, either by sprinkling frequently after the mortar has set hard enough to permit it or by hanging wet burlap or other material over the surface.

Freezing—Stucco should never be applied when the temperature is below freezing.

FINISH

Smooth Troweled—The finishing coat shall be troweled smooth with a metal trowel with as little rubbing as possible.

Stippled—The finishing coat shall be troweled smooth with a metal trowel with as little rubbing as possible, and then shall be lightly patted with a brush of broom straw to give an even, stippled surface.

Sand Floated.—The finishing coat, after being brought to a smooth, even surface, shall be rubbed witih a circular motion of a wood float with the addition of a little sand to roughen the surface slightly. This floating shall be done when the mortar has partially set.

Sand Sprayed. — After the finishing coat has been brought to an even surface, it shall be sprayed by means of a wide, long fibre brush—a whisk-broom does very well—dipped into a creamy mixture of equal parts of cement and sand, mixed fresh every 30 min. and kept well stirred in the bucket by means of the whisk-broom or a paddle. This treatment shall be applied while the finishing coat is still moist and before it has attained its final set, i. e., within 3 hrs. to 5 hrs. To obtain lighter shades add hydrated lime of 5% to 15% of the volume of the cement.

Splatter Dash or Rough Cast.—After the finishing coat has been brought to a smooth, even surface and before attaining final set, it shall be uniformly coated with a mixture of 1 part cement and 2 parts of sand thrown forcibly against it to produce a rough surface of uniform texture when viewed from a distance of 20′. Special care shall be taken to prevent the rapid drying out of this finish.

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[3] Am. Concrete Institute, 27 School St., Boston

[4] Applies to back plastered walls, not sheathed

[5] Applies to sheathed walls only

Pebble Dash—After the finishing coat has been brought to a smooth, even surface, and before attaining initial set, clean round pebbles of other materail as selected, not smaller than ¼″ or larger than ¾″, previously wetted, shall be thrown forcibly against the mortar so as to embed themselves in the fresh mortar. They shall be distributed uniformly over the surface of the final coat and may be pushed back into the mortar with a clean wood trowel, but no rubbing of the surface shall be done after the pebbles are embedded.

Exposed Aggregates—The finishing coat shall be composed of an approved, selected coarse sand, marble dust, granite dust or other special material, in the proportion given for finishing coats and within 24 hrs. after being applied and troweled to an even surface, shall be scrubbed with a stiff brush and water. In case the cement is too hard a solution of 1 part hydrochloric acid in 4 parts of water by volume can be used in place of water. After the aggregate particles have been uniformly exposed by scrubbing, particular care shall be taken to remove all traces of the acid by thorough spraying with a hose.

Mortar Colors—When it is required that any of the above finishes shall be made with colored mortar, not more than 6% of the weight of Portland cement shall be added to the mortar in the form of finely ground coloring matter.

A predetermined weight of color shall be added dry to each batch of dry fine aggregate before the cement is added. The color and the fine aggregate shall be mixed together and then the cement and the lime mixed in. The whole shall then be thoroughly mixed dry by shoveling from one pile to another through a ¼-in. mesh wire screen until the entire batch is of uniform color. Water shall then be added to bring the mortar to a proper plastering consistency.

The accompanying illustrations suggest the possibilities of stucco as a modernizing agent for old buildings, this field opens the way to a source of work that should readily be secured by intelligent, active solicitation backed by expert workmanship.

Figs. 1 and 2 show the Alta State Bank, Alta, Ia., as modernized by P. P. Comoli[6] who describes the work as follows:

The building, as shown in Fig. 1, is a frame structure veneered with common brick, erected about 30 yrs. ago. The window caps are of concrete applied to the brick at a later date.

The improvements, as shown in Fig. 2, consist of new windows, cornice and belt course molded in place, and stucco. After the windows had been remodeled pilasters were built of brick with cast stone bases and caps. The space over the windows and the cornice and belt course were built roughly to shape with brick. Concrete window sills and coping were cast in place and the brick work of the old cornice trimmed to the necessary level to receive stucco.

Stucco was applied in two coats, the second coat being manipulated so as to show the desired letters and ornaments. All ornamental work is flush and is of the same stucco as the body of the work. No coloring matter is used, the different colors and shades being secured entirely by the surface manipulation of the stucco after it is spread and while still soft.

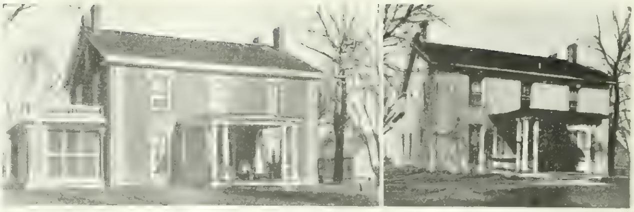

Fig. 3—An Old Brick House Before and After Applying Stucco

Next the entire building except pilasters, designs and the space below the first story window sills was given a coat of rough-cast stucco. The pilasters were finished after the application of the second coat, by scraping them at the right stage to expose the aggregate.

The light-colored trim is secured by adding water to the light portions with a brush soon after this stucco is applied and rubbing with a wood float. In this manner several shades can be produced by the skilled worker.[7]

In Fig. 3 is shown an old brick house modernized and made attractive through the use of stucco and the addition of a sun parlor.

Is This the Oldest Concrete Arch Bridge in America?

The accompanying illustration shows a concrete arch bridge three miles from Rock Rapids, Ia. This bridge replaced a number of earlier bridges destroyed by washouts and fires. The cost is unknown, but it was put in for the same price that the township would have paid for a wood pile bridge for the reason that the contractors, The Hewitt Co.,[1] wished to try out this type of structure experimentally.

The bridge was built in 1897, imported cement being used. It is not known just how the bridge is reinforced. As will be seen by the illustration the arch is of concrete with stone spandrels and posts and an iron pipe rail. Not a dollar has been spent for repairs to the bridge, outside of necessary grading of the road surface.

It will be remembered by many that CONCRETE recently described an arch bridge constructed by James W. Pearl,[2] in 1892, which antedates this structure by 5 years.[3] The bridge built by Mr. Pearl was, however, destroyed to make way for other improvements so that it is possible that the Rock Rapids bridge is the oldest existing concrete arch. This magazine would like to receive information as to older structures, if they exist.

Considering the various types of reinforcement now on the market it is a difficult proposition to select the best, and generally the selection is determined by the price submitted by the commercial engineers bidding under sub-contract to furnish the steel reinforcing. To a certain extent this method is dangerous but it is hard to suggest a remedy. Individual preference and experience are always a very large element.

Concrete Arch Bridge Built in 1892

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[6] Sioux City, Ia.

[7] See detailed description in CONCRETE, Apr., 1914

[1] Minneapolis

[2] Engr., Chicago

[3] Aug., 1915, p. 75

Developments in Operation of Factory Making Structural Tile

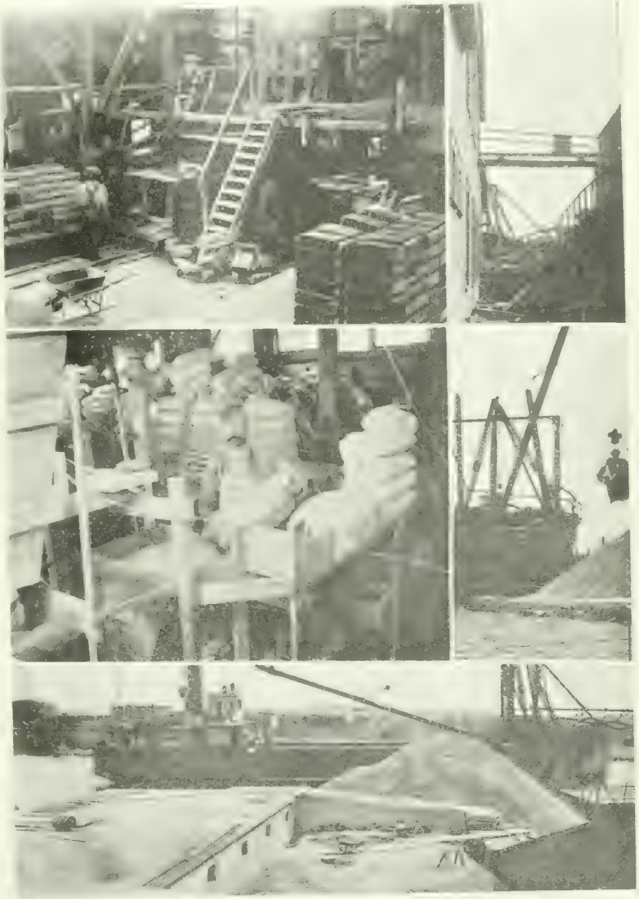
By Harvey Whipple

In developing the factory operation of the Delta Brick & Tile Co., Detroit, with the Eberling machine,[1] in an effort to meet a demand for its structural tile, which has been far in excess of the production, some interesting details have been worked out by the general manager, S. H. Wightman, and some are still being worked out to be put into effect in the new 10-machine factory which is to be erected in the near future.

The factory and operations of the company were described by the writer in the Feb., 1915, issue of this magazine. At that time, the factory had been in operation less than 6 mos. with one machine having a capacity of 14,400 tile units per 10-hr. da. That these notes on the development of equipment and operations may be more valuable, the operations are here briefly reviewed, as previously described in connection with the new features. At this time two machines are in operation; three more machines are under construction and it is proposed within the present year to add eight machines in all making a 10-machine plant.

THE TILE UNIT

The tile manufactured is hollow, with walls about 1″ thick, the size of the basic unit being 5″ x 4″ x 12″, the exposed face as laid in the wall being 5″ x 12″. The machine makes four of these tile at one operation or by an adjustment of knives and plungers, which divide, shape and compress the concrete, each operation will produce two tile 5″ x 8″ x 12″; one tile 5″ x 12″ x 12″ and one 5″ x 4″ x 12″ or one tile 5″ x 16″ x 12″. The greater portion of the output is in units 5″ x 8″ x 12″, equivalent as laid in the wall to 6.4 common brick. So one machine making 7,200 of this size produces the equivalent of 46,000 brick per da.



Figs. 1-5 Plant of the Delta Brick and Tile Co., Detroit

(1) Upper Left—General view of the factory, showing two tile machines just below the edge of the balcony or partial second floor on which mixer operates and above which cement and aggregates are delivered. (2) Upper Right—Gravity conveyor delivering cement in bags on pallets from railway car to factory. (3) Middle Left—Cement being delivered on gravity conveyor to mixer man; the aggregate chute from screen and conveyor belt and the hopper are shown at extreme left. (4) Middle Right—Coarse, deep-dredged lake sand being unloaded by clamshell from barge onto factory property. (5) Lower view shows rear of property from factory roof; the housing of the belt conveyor for aggregates is shown at the extreme right.

AGGREGATES

The aggregates used are: dolomite screenings, up to ½″ with all fines out and deep dredged lake sand passing a ½-in. screen. The mixture is usually 1 part cement, 2 parts sand and 2¼ parts screenings. These are handled separately by shovels and wheelbarrows into separate compartments of a hopper in the plant yard. The proportioning is mechanically gauged and adjusted by means of gears operating worms, one at the bottom of each of the two hopper compartments, the stone and sand feeding to a 14 in. Leviathan canvas belt[2] 200′ long, which carries the material to the top of the plant to a screen which rejects the few over-size particles and passes the aggregates to a large hopper above the mixer. For the 10-machine factory when completed hand work on aggregates will be eliminated. Stone will be shipped in

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[1] Eberling Machy. Co., Cleveland

[2] Main Belting Co., Philadelphia

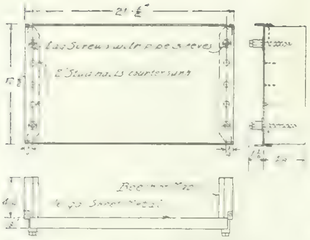

Fig. 6—Details of New Steel and Wood Pallet

dump-bottom cars emptying directly into a two-car capacity hopper feeding directly to the belt conveyor. Sand will also be unloaded directly into a hopper. It is now delivered by boat and unloaded by clam-shell to a stone pile to be re-shoveled.

HANDLING CEMENT

Cement which is delivered in cars on a railway trestle above the second floor level was at first unloaded by truck and piled on the second floor. One development came with the increase of output to the point where about 1 car of cement was used each day. The cement car now stands all day beside the factory and one laborer gives about one-half his time to unloading by means of a gravity carrier.[3] The carrier extends from the mixer to the car and carries the cement on pallets 4 bags at a time down a very gentle grade to the very elbow of the mixer man. This man sees that the aggregate feed does not clog and keeps the cement hopper filled, dumping and shaking the bags that come within reach and piling them onto a bag bundler[4] about two paces from the mixer, in which they are counted and fastened in bundles of 50.

MIXING AND MOLDING

The continuous mixer, which stands on the second floor level, was specially built and has proved satisfactory in maintaining positive proportions and in giving long and thorough mixing, made possible by an unusually large number of paddles and by the length of the trough. The mixed concrete feeds to a hopper above the tile machine which stands on ground floor level. At this time, with two machines, the flow of mixed concrete is divided by a metal plate below the spout, so that one-half of the concrete falls into the hopper of the machine immediately below and one-half drops onto a rubber belt,[5] which carries it forward to the hopper of the second machine. In a new plant, the details of which are now being worked out, two larger mixers will be employed to serve 10 machines by means of belt conveyors.

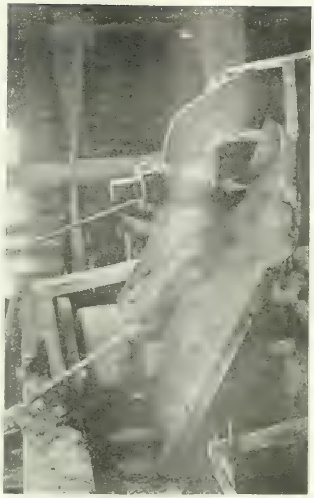

Fig. 7—Chute from Mixer: Plate Dividing Flow of Concrete Between Hopper and Belt is Controlled by Rod Within Reach of Machine Operator

In the operation, the surplus concrete shoved out by knives and plungers in forming the tile, drops through the table of the machine to a rubber belt[5] in a pit below the machine, from which it is lifted to be deposited when at a proper height, on a return belt which redelivers it to the machine hopper.

PALLETS

The tile have been molded on wood pallets which have sides of such height that racks are not used on cars but pallets are piled one on another. Wood pallets have deteriorated rapidly and been reduced in comparatively short time to a soft, punky consistency. They have warped, splintered and cracked, resulting in a rather high percentage of tile breakage. This experience led the Delta Brick & Tile Co. to the design of a pressed steel pallet[6] with sides of hard wood, as shown in the accompanying details. The steel and the wood parts are being assembled at the Delta factory, the net cost on the first lot being about 50 cts. each. A second lot will undoubtedly reduce this figure by 20%. These new pallets are now being treated in a steam heated bath of kerosene and paraffin oil.

CURING

Tile as removed from the machine on pallets are piled on simple cars with plank decks for removal to the curing rooms, which have been supplied with moisture and heat by steam at 5 lbs. pressure from a perforated pipe on the floor at the center of each kiln.

The desirability of at least 48 hrs. curing in these rooms, in the face of a demand for tile which necessitated more rapid and economical methods, prompted experiments now being made with a blower apparatus[7] to effect more rapid curing by constantly re-heated atmosphere with a maximum of moisture. As now being installed this apparatus is merely diagrammed, not detailed, in the accompanying sketch.

Instead of doors at both ends the new experimental curing room has one dead end—the end at the right in the diagram. It is built to accommodate a string of loaded cars fitting close all around, giving a minimum of waste space above and at the sides of the cars. The tile are so piled on the cars that their cored centers, when cars are placed end to end, form a series of tubes the entire length of the curing room. At the dead end of the room is a metal hood covering the end of the

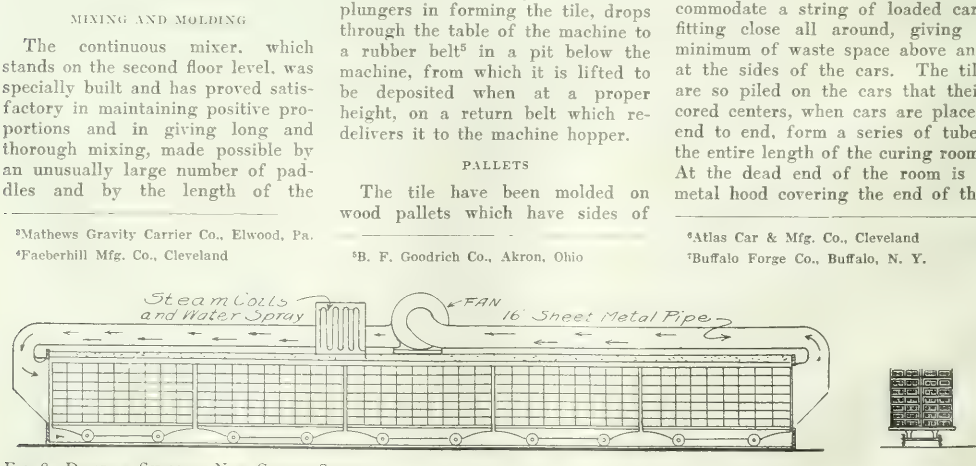

Fig. 8—Diagram Showing New Curing System

tile load. Another metal hood on the door of the room is so constructed that when the door is closed it covers the ends of the tiles. Steam at 150 lbs. pressure (this is thus far tentative and experimental) and a water spray are both admitted to a heated chamber, from which a powerful fan forces the hot moisture-laden air into the curing room through a 16-in. metal pipe to the hood at the door end of the curing room. Instead of spreading out the heat and the moisture around and on the products, as in most curing rooms, the idea of this experimental installation is to take advantage of the nature of the product in affording a series of tubes, by forcing the heat and moisture through as well as around the products, and pulling back the partially cooled moisture to be re-heated and re-humidified. The drip, from the condensation of the returned moisture will be returned to the boiler, thus saving materially in heat necessary by avoiding the heating of a new supply of moisture. In this way it is proposed to make effective a high percentage of the heat and moisture utilized, rather than wasting it, as in many curing rooms. This will be done by a rapid re-circulation of a relatively small amount of air, and by conveying the moisture with small heat losses from absorption and radiation.

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[3] Mathews Gravity Carrier Co., Elwood, Pa.

[4] Faeberhill Mfg. Co., Cleveland

[5] B. F. Goodrich Co., Akron, Ohio

[6] Atlas Car & Mfg. Co., Cleveland

[7] Buffalo Forge Co., Buffalo, N. Y.

GRAVITY CONVEYORS

Gravity conveyors have been used very extensively. When cars of cured tile are removed from the curing rooms after 24 hrs. they are moved on transfer tracks and a turntable to secondary curing rooms. The building containing these rooms has only recently been erected. It is built of the concrete tile, affording good heat insulation. This building is heated in winter with a very small supply of moist steam and has capacity for 750,000 tile. Tile are unloaded by gravity carriers from cars to these rooms and from them are loaded by gravity carriers to motor trucks or railway cars.

Two lots of cars of different gauge have necessitated three rails to accommodate two widths of track. The arrangement of tracks, turntable, cross-over and transfer are shown in the accompanying illustrations from photographs. By having two sets of tracks alongside the secondary curing rooms, there are no delays and men can be kept at a job of unloading cars from the steam rooms until the job is done for the day. The empty pallets come back on a car by gravity, the track having just enough grade to return the car to the proper place in the factory for unloading and re-using pallets at the machine. The car on the other track from which the tile are unloaded is light enough when empty to be picked up and lifted to the return track, where it is ready in turn for its load of empty pallets from the next car of tile.

Figs. 9 and 10—At Left, Unloading Tile from Cars to Gravity Conveyor for Storing in Secondary Curing Room; at Right, Loading Ry. Car by Gravity Conveyor from Secondary Curing Room

NEW DESIGN OF CAR

The cars in use have not been satisfactory. Not only have wood and metal deteriorated rapidly but the beams of the car on which the load bears were placed so wide apart as to put an excess of load in the center. This has depressed the plank decks and resulted in damage to tile through uneven bearing. Mr. Wightman has designed a new car with deck and beams of reinforced concrete, which will distribute the load evenly and which is expected to give much longer service. It is shown in the accompanying details.

UNLOADING DEVICE

Cars will not play so big a part in the factory operations when the new 10-machine factory is built. Every possible step has been taken to reduce manual labor. This, it is expected, will be greatly reduced in the operation of a car unloading device now being built. This will unload cars as they come from the first curing room, lifting an entire tier of tile at a time, raising this load to a height of about 30′ above the factory floor, and turning it completely over so as to place the tile on a gravity conveyor and by another movement placing the pallets on another gravity conveyor for return to the machines. The tile will roll by gravity to the secondary curing rooms, the stream of tile being diverted to any one of the small rooms and the flow guided by a man in charge at that end. As the starting point will be at a high level, the tile will be delivered under sufficient head so that a steel chute in which the conveyor will terminate may be raised as successive tiers are placed.

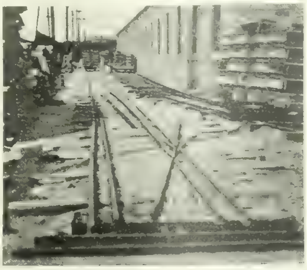

Fig. 11—Double Track System for Outgoing and Incoming Cars Between Factory and Secondary Curing Rooms

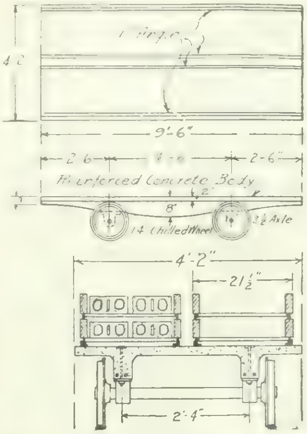

Fig. 12—Details of New Car; the End Section, Below is Drawn Twice the Scale of Plan and Side Elevation

In connection with the unloading device an electrically operated transfer car will be used which will shove the cars on and off curing room tracks.

The development of the factory has been purely a quantity proposition ever since Mr. Wightman made an elaborate series of experiments and trials to arrive at the best proportions and quantities of materials to give the densest possible concrete, and in a consistency to be manipulated successfully in the machine.

The machine itself is being improved by the manufacturers profiting by the experience of the Delta plant and it is expected that the machine with which the new Detroit factory will be equipped will have greater capcity; wearing parts more readily replaceable and by slightly different arrangement of cores, give a product of greater strength and stability.

The success of the plant in the Detroit field has been phenomenal. Between Feb. 1 and June 1 the company had orders for 6,750,000 tile units or considerably more than double the output in that period based on getting maximum capacity out of both machines.

This business has been built up against prejudice, on the basis of a quality unit sold at such a price that it could be laid in the wall considerably cheaper than common brick, to which it is now preferred by numerous architects and builders.

The Eberling tile has met with the approval of architects and builders because: there is a saving in labor and mortar in laying up; it has good load-carrying capacity; it affords good mortar and stucco bond; good insulation is provided by the multiple coring—a 12-in. wall having 5 air spaces.

A Products Manufacturer's Sales Campaign

A products manufacturer in the center of a fairly prosperous farming community bought an outfit[1] to make concrete fence posts. He made a lot of good posts and piled them in his yard. They stayed there. Nobody in particular knew he was making good concrete posts. So nobody came to buy.

Then one day somebody came along with an idea and here's the way it worked out:

The products manufacturer put three posts in the back of his car and went out to call on prosperous farmers in his county. He drove into one farm gate after another and asked the farmer if he didn't find that wood fence posts went to pieces rather fast; showed him the posts he brought along; got him interested in the idea of using a material that would stay put, and as he drove away he told the farmer to drive in to his factory some day and he'd give him 10 posts for a trial. The products manufacturer called on 20 farmers, scattered all over the county, and then he went back to his work. One by one the 20 farmers came in to the factory, each to get his 10 posts. Incidental, but very important in this sales campaign, is the fact that the farmer saw the posts in the making and also saw other concrete products, feeding boxes, watering troughs, building units, vases. The products manufacturer reminded each farmer before he drove away of the one condition attached to the gift of 10 posts—that they be put into use at once, with wire strung on them. The P. M. suggested that if the farmer could use the posts along the front of his property it would not only improve the front but would be a better advertisement for the post, and of course the P. M. told the farmer very frankly that his object was advertising. When a farmer got home with his posts he replaced a rotten wooden post here and another one farther on and so on, and fastened his wires. He was impressed by the fact that the few trim, substantial concrete posts looked so good that the old wood posts looked very bad in comparison. As time went on, the comparison was more marked. Eventually he went in and bought more concrete posts to finish out a line and make it all look uniformly good.

To come quickly to the moral of this true story, it must be recorded that the products manufacturer gave away about 200 posts—total actual cost to make less than $40. He got 20 prosperous farmers to come and see his factory. Every one of the 20 became a customer—buying not merely posts but buying other concrete products, the existence of which in his own locality he otherwise might never have known. And that isn't all. In having a trim, orderly factory to show, the products manufacturer did a lot to build up a general confidence in the things he made. When he introduced 20 farmers to his plant and showed them what and how things were made there, he set loose 20 casual salesmen—so that 20 customers were multiplied by the number of their friends and acquaintances and also by the passers-by who saw that Jones, a prosperous farmer, had replaced his wood posts with concrete.

Soap-and-Alum Waterproofing

The soap-and-alum process in waterproofing has been used frequently by engineers of the War Department. It is described in the 1901 report of the Chief of Engrs., U. S. Army, as follows:

The soap-and-alum (Sylvester) process was used in "waterproof mortar" and applied to both horizontal and exposed vertcial surfaces. This mortar was made by taking 1 part cement and 2½ parts sand and adding thereto ¾ lb. of pulverized alum (dry) to each cu. ft. of sand, all of which was first mixed dry, then the proper amount of water—in which had been dissolved about ¾ lb. of soft soap to the gal. of water—was added and the mixing thoroughly completed.

The mixture is a little inferior in strength to ordinary mortar of the same proportions and is impervious to water, and is also useful in preventing efflorescence. The alum is in excess for the reason that it coagulates other things than soap that may come to it.

The process was applied in connection with concrete construction in fortifications at New York Harbor. Similar treatment is known to have been used somewhat extensively elsewhere in work of like character.

Concrete Paving Leads in Seven States

Figures compiled by *Municipal Journal* show that in the following Central states—Ind., Ill., Ia., Mich., Minn., Mo. and Wis., concrete leads as a paving material, as shown by the table:

		1914 Yardage	1915 Yardage
1	Concrete	2,600,396	2,983,199
2	Brick or clay block	2,482,292	1,907,882
3	Sheet asphalt	2,064,589	2,657,630
4	Bit. concrete	1,214,510	1,916,732
5	Bit. macadam	930,232	819,397
6	Creosote wood block	907,749	427,551
7	Gravel	523,753	563,872
8	Waterbound macadam	393,035	571,014
9	Granite or sandstone block	215,032	129,082
10	Bitulithic	150,446	321,563
11	Concrete with bit. top	117,200	172,656

The big feature in modern building is concrete. The construction tower is a feature of every city and a mark of a town's prosperity.

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[1] Staple Post Mold Co., Westerville, Ohio

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Splicing Reinforcing in Heavy Circular Construction

THE FOLLOWING QUESTION IS DISCUSSED BY:

C. A. SAMPSON[1]
W. C. POLK[2]
N. P. WINCHELL[3]
E. K. CONKLIN[4]
J. R. WORCESTER[5]
L. C. WASON[6]

"Taking into consideration economy of materials, what is the best method of splicing reinforcing bars in heavy circular construction? Do you consider the use of wire rope clips economical for this work?"

BY MR. SAMPSON

As to the relative merits of bonding reinforcement in circular concrete structures, I can assure you that this subject is open to many opinions. For actual tests of the efficiency of the use of clips, I would refer you to *Transactions* of the Am. Soc. of C. E., 1914, Vol. 77, p. 1,056. Tests were also conducted by the Watertown, Mass., Arsenal in connection with the Attleboro, Mass., standpipe, which proved that two clips properly secured develop the full working strength of 1½-in. round rods. In the construction of circular concrete structures of considerable size which require closely spaced horizontal reinforcement and necessitate pouring in successive rings, it does not always happen that the day's work can be ended at a point at which the last horizontal reinforcing rod embedded and the one to be embedded on the succeeding day will be sufficiently surrounded with monolithic concrete to develop the full tensile strength of the bar where lap alone is relied upon for splicing and it is for this reason, as well as to overcome the uncertainty of concrete construction, that I would recommend the use of clips on important structures. If two clips (Crosby[1] or equal) have been tested to give the full strength of the reinforcement, there would seem no good reason to use three or four clips, as has been done, especially since the bond between steel and concrete is worthy of some consideration, even under the most unfavorable conditions.

BY MR. POLK

We have had no experience along this line, but believe it would be rather expensive and perhaps not so positive as the practice of lapping the steel, which we have always done, and have never experienced any trouble.

BY MR. WINCHELL

Our experience would lead us to believe that the best method of bonding reinforcing bars for circular construction is to lap the rods at least 50 diam. so that the bond of the rod with the concrete will give the necessary strength without any tying or splicing of the rods.

BY MR. CONKLIN

We consider that lapping the reinforcing and tying with wire is perhaps one of the best and cheapest ways of splicing reinforcing when the strains are very heavy. Using clips would perhaps be a little expensive and it would take some time to make the splices. We consider it necessary to make splices of 2′ or more on any heavy work. We do not recommend the loop splice, as we cannot see where it is as strong as the lap splice. In our circular construction we use and recommend wire mesh reinforcing, as we believe that it is more evenly distributed and more easily put in, although we have contractors who use the rod reinforcing. Rods can be bought more cheaply than the wire mesh, but we consider that the mesh will save us time in placing. Splicing rods or mesh is one of the most important things in placing reinforcing, and should be well done.

BY MR. WORCESTER

I have no definite results of tests upon which to base my opinion with regard to the splicing of rods in heavy circular construction. I have, however, a strong prejudice against any form of mechanical bond and in favor of a lapping of sufficient length to transfer the stress from one rod to the other by means of the concrete. My objection to the mechanical bond is that I am not acquainted with any device the strength of which is developed without a very definite and perceptible motion. The ultimate strength may be all right, but a slight motion in order to develop the strength may be fatal to the concrete.

BY MR. WASON

We have built two reinforced concrete stand pipes. In each case we used Crosby[1] guy rope clips. At the time of building the first stand pipe we made some tests of the value of this clamp at the Watertown Arsenal by taking two bars of short lengths, clamping them together with three clips, and finding that thereby we developed more than the working stress of the bars without any slip. The factor of safety, however, as nearly as I can remember, was not more than 1½. I cannot quote exact figures. Clips were tested on bare bars, embedded in concrete; there would, of course, be a still greater bond; perhaps it would run the factor up to a quarter part more. It is necessary to have the guy rope clips made to order, because the standard ones are oval in shape, in order to jam a wire rope, whereas with a round bar it is necessary to have a tight fit on a circular surface to get the best grip. We considered the clips economical for this purpose, as we used extremely long bars, 60′ or thereabouts, so that there were only three bars and three splices to a whole circumference for a 50-ft. circle. We have also used for building work ordinary welding by heating in a furnace, with good results. We have made welds strong enough so that a bar twisted afterwards cold did not break at the splice.

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[1] Prin. Asst. Engr., Robert Spurr Weston, Boston

[2] Pres., Polk-Genung-Polk Co., Ft. Branch, Ind.

[3] Vice-Pres., Simpson Bros. Corp., Boston

[4] Conklin Const. Co., Hartford, Mich.

[5] Consult. Engr., Boston

[6] Pres., Aberthaw Const. Co., Boston

[1] Am. Hoist and Derrick Co., St. Paul

A still more recent method, about which we know little, is that of electric welding, which might be done more economically than the application of three guy rope clips, and it certainly gives most excellent results as to strength.

Correspondence: A Department in Which the *Reader* Becomes the *Writer*

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow."

Concrete—A Retrospect

A Letter From A. M. Wolf[1]

In the year 1900 the Assn. of Ry. Supts. of Bridges and Bldgs., now The Am. Ry. Bridge and Bldg. Assn., published a pamphlet giving the answers to a list of questions sent to the chief engineers or similar officers of the more important railway lines in America and to all of the members of the Association, covering the general subject of concrete construction. This bore the heading: 'Is Concrete a Suitable and Economical Material for Bridge Piers, Abutments and Railway Culverts and Arches?"

Such a question asked today would be cause for expert examination as to training or condition of mind, but in the early days of the industry it was a most natural question to ask. Stone masonry was almost universally used for these structures and, true to their traditional conservatism, engineers were disinclined to use a new material unless its worth and economy had been proven by experience.

At the time of its publication this pamphlet was no doubt a fairly complete resumé of practice and a valuable kind of information on the subject, but at the present time could hardly be considered in this light. It served its purpose, however, and no doubt did much toward the standardization of cement manufacture and the application of concrete for many of the replies pointed out the need of standardization as a benefit to the industry.

One interesting feature disclosed was the extensive use of concrete even at this early day by some of the railroads, which enabled conclusions to be drawn as to its value as a construction material, which have proven entirely correct. The reply of H. W. Parkhurst, then engineer of bridges and buildings, Illinois Central R. R., to a question asking for reasons for or against the use of concrete in railway bridge or building work, is indicative of this fact and is at the same time quite applicable at the present time.

Mr. Parkhurst said:

> "Concrete is preferable to stone masonry on account of its greater cheapness; the fact that work can be done without the use of derricks and heavy machinery; that complicated structures can be built by the aid of molds and that work can be handled in restricted quarters which would be impossible to carry on with cut stone. It has especial advantage in reinforcing cut stone masonry, either bridge piers, arch culverts, abutment walls, parapets, etc., where a mold can be constructed and a good bond made between the old and the new work."

Many new uses and methods of application and construction have been devised for concrete since 1900 but such advances are only natural with a material, the advantages and economy of which were so clearly recognized, even in the very infancy of the industry. In the early days concrete structures were made massive and much heavier than necessary in many cases because of ignorance as to its behavior under all conditions. Experience has, however, shown that reinforced concrete structures can be of relatively light construction if properly designed and we are now entering a period marked by economy in the use of materials.

Organizations

American Concrete Institute, Leonard C. Wason, President, 27 School St., Boston.

American Concrete Pipe Association, Secretary, E. S. Hanson, 538 S. Clark St., Chicago.

American Highway Association, Colorado Bldg., Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C.

Association of American Portland Cement Manufacturers (Portland Cement Association), J. P. Beck, Gen. Mgr., 111 Washington St., Chicago.

Cement Products Exhibition Co., 210 S. LaSalle St., Chicago, Ill.; Blaine S. Smith, Sec'y.

Mid West Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb.

Blaine S. Smith to Have Full Charge of Next Cement Show

At the adjourned annual meeting of stockholders of the Cement Products Exhibition Co., held May 23, 1916, the following directors were elected: B. F. Affleck, Universal Portland Cement Co.; A. Y. Gowen, Lehigh Portland Cement Co.; J. U. C. McDaniel, Chicago Portland Cement Co.; W. E. Cobean, Wolverine

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[1] Prin. Asst. Engr., The Condron Co., Chicago

Portland Cement Co.; Wm· Dickinson, Marquette Cement Mfg. Co.; D. McCool, Newaygo Portland Cement Co.; Robt. F. Hall, Portland Cement Assn.; Arthur Cameron, Municipal Engrg. & Contrg. Co.; Blaine S. Smith, Universal Portland Cement Co.

The directors elected the following officers: B. F. Affleck, pres.; A. Y. Gowen, vice-pres.; Blaine S· Smith, secy.; J. U. C. McDaniel, treas. The directors elected the executive committee as follows: Blaine S. Smith, chmn.; A. Y. Gowen, J. U. C. McDaniel.

Manual Training in Concrete

In reference to manual training in concrete work, the Portland Cement Assn. makes the following announcement:

> Manual training in concrete has been one of the recent additions to vocational courses in many schools. As a result of the unusual interest which this work has created the Portland Cement Assn. has been deluged during the last few months with requests for information on Manual Training in Concrete, and a number of instructors have already expressed a desire to visit Chicago during the summer for the purpose of obtaining direct from the cement industry greater insight into this work.
>
> With this object in view a Short Course on Concrete under the direction of the Extension Division of the Portland Cement Assn. has been arranged, on which occasion manual training and vocational teachers will have an opportunity to acquaint themselves with the fundamentals required for the successful teaching of this subject.
>
> The Short Course will include lectures, demonstrations, classroom and laboratory work. As an aid to the conduct of the course the laboratories and lecture rooms of the Lewis Institute have been placed at our disposal. Several topics in the course will be illustrated with motion pictures, lantern slides, charts and models, while an opportunity will also be given to those in attendance actually to perform various classes of concrete work. Schools which are now regularly carrying on concrete courses will be asked to send course outlines, drawings, report forms and photographs, as well as specimens of their form work and concrete exercises, which will be on exhibition during the course.
>
> 1. Materials for Concrete, Tests, Methods of Selection, Proportioning.
> 2. Mixing and Depositing Concrete.
> 3. Tools and Equipment for Manual Training Concrete Work.
> 4. Forms for Simple Exercises.
> 5. Surface Treatments.
> 6. Methods of Curing Concrete Products.
> 7. Watertight Concrete: Methods of Repairing Leaky Cisterns and Tanks.
> 8. Fundamental Principles of Reinforcing.
> 9. Concrete Highway Construction.
> 10. Practical Problems for Concrete Classes.
>
> Enrollment is open to supervisors and instructors in manual training work without charge. The accommodations are necessarily limited, owing to the large amount of space and equipment required for the rather extensive demonstration work, and preference will be given applications according to the order in which they are received. There will be no expense whatever connected with the course except for meals and lodging, for which arrangements have been made at very moderate rates. Applications for enrollment should be sent to A. J. R. Curtis, director Extension Division, Portland Cement Assn., 111 West Washington St., Chicago.

Meeting of the Am. Soc. for Testing Materials

The nineteenth annual meeting of the Am. Soc. for Test. Mat. will be held at the Hotel Traymore, Atlantic City, N. J., June 27-30, 1916.

The program is announced as follows: Tuesday, June 27, A. M., Reports of the committees, election of officers; Tuesday, P. M., Papers on miscellaneous materials; Tuesday Evening, Presidential Address, and Heat-Treatment of Steel; Wednesday, A. M., Steel and Iron; Wednesday, P. M., Tests and Testing.

Thursday's sessions will consist of papers of direct interest to the concrete field, as follows:

Thursday, A. M.; Report of Committee C-1, Cement, Geo. F. Swain, Chairman; Report of Committee C-9, Concrete and Concrete Aggregates, Sanford E. Thompson, Chairman; Report of Committee D-8, Waterproofing, W. A. Aiken, Chairman; The Specific Gravity of Non-Homogeneous Aggregates, Prevost Hubbard and F. H. Jackson; Autoclave Cement, H. J. Force; The Strength of Clamped Splices in Concrete Reinforcement Bars, E. L. Lasier; A Method of Making Wear Tests of Concrete, D. A. Abrams; A New Form of Specification for Concrete Material, Cloyd M. Chapman.

Thursday, P. M.—Report of Committee C-4, Clay and Cement Sewer Pipe, Rudolph Hering, Chairman; Report of Committee C-6, Drain Tile, A. Marston, Chairman; The Effect of Temperature during and after Immersion upon the Results of Absorption Tests of Drain Tile, W. J. Schlick; Practical Methods for Testing Refractory Bricks, C. E. Nesbitt and M. E. Bell; Report of Committee D-4, Road Materials, L. W. Page, Chairman; Evaporation Loss Tests on Asphalts, R. O. Fitch.

The Friday A. M. session is devoted to papers on Non-Ferrous Metals and Cast Iron, and the afternoon to the consideration of miscellaneous materials.

Summer Engineering School

A summer session of the College of Engineering, University of Wisconsin, will be held during the six weeks beginning June 26. Special courses in chemistry and engineering will be given. A booklet with full information in regard to courses, rates and other information can be obtained from F. Turneaure, Dean, Madison, Wis.

The Industrial Arts Index, published by the H. W. Wilson Co., White Plains, N. Y., indexes the contents of about 80 periodicals devoted to trades and manufactures, mining and metallurgy, lighting, heating and ventilation, etc., CONCRETE being the representative in the index of its special field. All articles of any importance whatever are indexed under as many subject-headings as the contents demand, and considerable use is made of cross-references to direct the searcher for information to all sources where desired material may be found. The Index is issued five times a year, in Feb., Apr., June, Oct. and Dec., and each number is fully cumulated from the beginning of the year to date of issue. This makes it unnecessary to use any but the latest number at any time for a complete record for the year to date of issue. The Dec. number for each year is the annual cumulation, and is furnished bound in library buckram. The only method by which this index can be brought within the reach of all to whom it would be useful and still guarantee to the publishers sufficient support to warrant them in continuing its publication, is by making a subscription rate based on the number of periodicals which each subscriber receives.

A Correction

Through an error, the article on "Forms for Concrete," in the May, 1916, issue of CONCRETE was credited to Robert Sherwin. This article was by R. A. Sherwin, Supt. for the Aberthaw Const. Co., Boston.

Every man who can afford a car can afford a garage. Ask local dealers for weekly reports as to new car owners.

The top coat adds greatly to the cost of sidewalks and floors and in many cases the work would be better if the high finish were omitted.

Construction of a Sanitary and Fireproof Concrete Creamery Building

A large creamery and cheese factory has recently been built at Slate Hill, N. Y., by The Clover Farms, Inc., N. Y. C. The building was designed to combine permanent fireproof construction with moderate cost.

A study of the illustrations show that the building is 42′ x 166′, of which 90′ is two stories in height and the remainder one story. As the building sets in a bank, considerable retaining wall work was necessary.

The milk is taken in on the second floor level and flows by gravity to a mezzanine floor 7′ above the main floor, where it is separated. It then again flows by gravity to other departments.

All wall work is double, consisting of two 6-in. walls separated by a 2½-in. air space. The walls were built with a hollow wall machine[1] and plastered outside and inside on the rough surface left by the machine. Each wall is reinforced with No. 9 iron wire 9″ o. c. horizontally and tied together with No. 6 wire ties about 2′ apart at every 9-in. course, the ties averaging about one per sq. ft. of wall. One-half-in. rods were used over all small openings and at the large openings in the boiler room heavier bars were used. Bank-run sand and gravel were used as aggregate and hauled about 2 mi. at a cost of 50 cts. per yd. and 15 cts. per yd. was paid for the gravel at the pit. About 650 cu. yds. were used in the construction, with about 750 bbls. of Vulcanite cement.[2] All material was mixed and handled by hand. About 12 men were employed and the work occupied about 3 mos. Of this time about 1 mo. was for excavating and foundation work and for finishing after the walls and roof were up; 23,000 sq. ft. of 5-in. flooring were placed, a gang being employed on this work about 24 das. The concrete base was first laid and then a 1¼-in. top coat with floor hardener[3] was placed at once. The mezzanine floor was built over metal Floretyle.[4] The walls were finished with stucco 1:3 with 5% of hydrated lime and a sand finish was used inside and out. There were 1,300 sq. yds. of plastering outside and about 1,500 yds. inside. The plastering cost was about 38 cts. per sq. yd. The cost of the rough wall was about 12½ cts. per sq. ft. The main roof is covered with slate.

Steel factory sash[4] was used throughout. The cost of the building complete ready for machinery was about $16,000. The building was erected by George DeLap[5] and the wall construction was under the direct charge of George E. Lewis.[6]

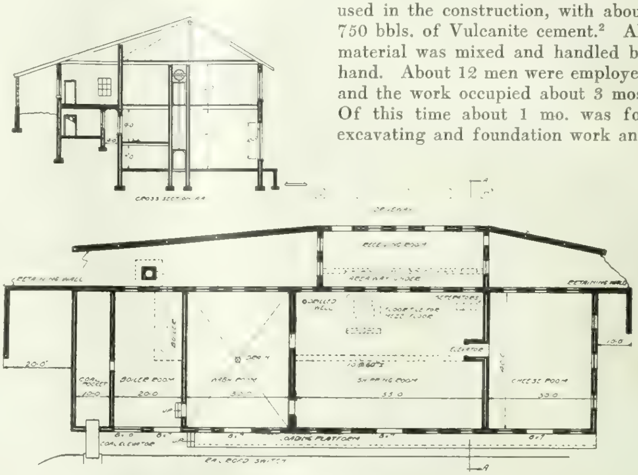
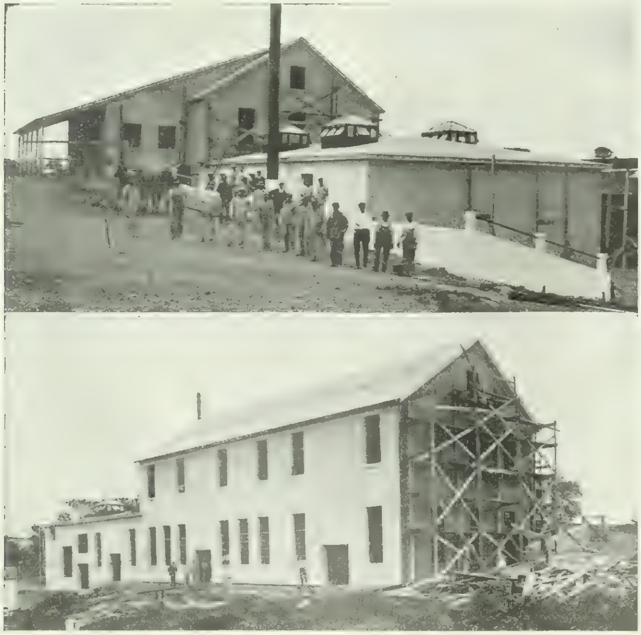


Fig. 1—Plan and Section of Creamery at Slate Hill, N. Y.



Figs. 2 and 3—General Views of Creamery

All bends in reinforcing bars should be carefully examined for cracks before placing the bars in position, a precaution which is not always observed.

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[1] Van Guilder Hollow Wall Co., Rochester, N. Y.

[2] Vulcanite Portland Cement Co., N. Y. C.

[3] Trus-Con Laboratories, Detroit

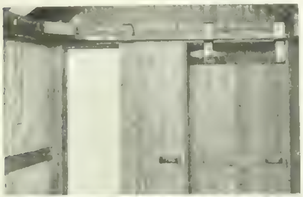
[4] Trussed Concrete Steel Co., Youngstown, Ohio

[5] Contr., Kenoza Lake, N. Y.

[6] Supt. for Van Guilder Hollow Wall Co., Rochester, N. Y.

New Equipment, Methods and Materials:
New Tools with Which the Industry Works □ □

The commercial development of machines, tools and materials, and the new methods which their use involves have a most important part in the progress of the concrete field. Announcements of such developments, particularly in reference to their demonstrated importance in actual practice, are welcome. The Editors will select for publication that material which conveys the information of most practical value to the Reader, without regard to other considerations.



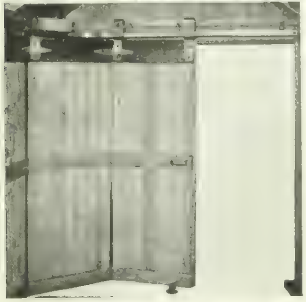


Fig. 1—Garage Door Arranged to Swing As One Unit and Slide Around the Corner

Fig. 2 Garage Door, Showing Position in Turning Corner

Curved Track Solves the Garage Door Problem

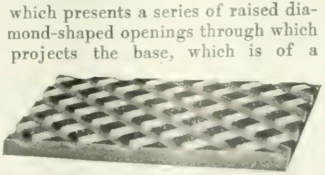
A satisfactory door arrangement for small garages has been very difficult to find. The wide opening in a small building makes it impossible to use a sliding door without taking up valuable space and using a more or less unsightly track outside the building. Swinging doors are also inconvenient and are liable to damage by high winds.

The illustrations show a sliding door arrangement[1] which is inexpensive and effective. Using this arrangement the doors are divided in comparatively narrow units and hinged together. Curved track is provided, as shown in the illustration. This allows the door to be slid around the corner inside the garage, where it is completely out of the way and fully protected. If desired, one section of the door may be arranged to swing, without in any way interfering with the working of the main door. This is shown in the illustration.

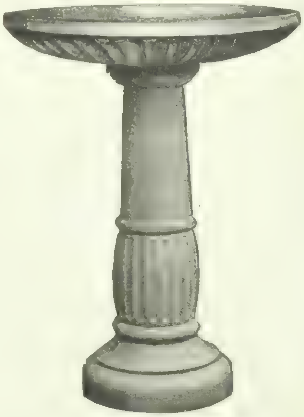
A New Type of Mason Safety Tread

The accompanying illustration shows a new type of tread[1] recently placed on the market. The tread retains the good features of the older types, including the deformed surface for catching foreign substances and the open groove at the end for drainage. The abrasive material is carried entirely through the tread so that it can be used until completely worn out.

The new tread is made of a skeleton metal frame, the surface of which presents a series of raised diamond-shaped openings through which projects the base, which is of a tough, abrasive mixture; it has been tested out for over a year at the main entrance of the Brooklyn bridge and is said to show very little wear under the heavy traffic. While these treads can be applied to all types of stairs, when ordered for new concrete work they are shipped with anchors attached, ready to be put in place.



The Mason Black Diamond Safety Tread



Concrete Bird-Bath

New Bird-Bath Mold

Now that there is a widespread interest in attracting wild birds about the home, there is an increasing demand upon concrete products manufacturers for bird baths. The one shown in the accompanying illustration is from a mold[1] recently placed on the market. The mold is in two parts, the basin 28″ in diam. and the pedestal to give a height of 34″, having a base 14″ in diam.

Special Hardware for Garage Doors

In the construction of concrete garages a very definite problem is

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[1] Louden Machy. Co., Fairfield, Ia.

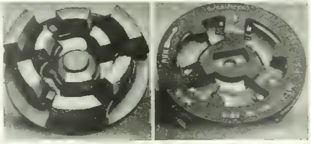
[1] The American Mason Safety Tread Co., Lowell, Mass.

[1] Architectural Mold Co., Detroit

A Concrete Garage with Folding Doors on Special Hinges

presented in constructing a door that will afford free access and which can at the same time be handled easily in all seasons.

A special line of door hardware[2] has been made available for this purpose. The illustration shows a garage of inexpensive construction where the entire front is made available as a doorway by using four doors hung on special hardware. A number of types of hangers are available to suit special conditions. A hint worth noting afforded by the illustration is the construction of fire-resisting doors by the use of corrugated iron on wood frame. A substantial and inexpensive door is secured.

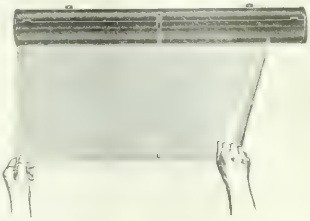


Cavicchi Floor Surfacers at Work in M. I. T. Bldgs. and Detail of Grinding Wheel

A Floor Surfacer with a Flexible Grinding Wheel

A new floor surfacing machine[3] has recently been given a thorough tryout and has been adopted for use in surfacing the floors of the new buildings for the Mass. Inst. of Tech., under the supervision of Stone and Webster Engrg. Corpn.

The illustration shows a number of these machines at work and also a close-up view of one of the machines and a detail of the grinding wheel. The machine is operated by one man and weighs, with an extra saddle-weight, 400 lbs. when in operation. The flexible wheel is made by securing three castings, each carrying three grinding blocks, to the main frame of the grinding wheel. These castings are allowed a certain amount of movement which enables them to reach high and low spots in the floor. The present machine is the outcome of long experience in designing stone finishing machinery.



Light-Proof Blue Print Paper Holder

A Light-Proof Roll for Blue Print Paper

A convenient storage for blue print paper, where it is safe from light and quickly and easily accessible in any quantity desired, has been provided by a light-proof roll holder, furnished with a steel tape by which the desired amount of paper can be conveniently measured. A cutting edge is arranged so that it is only necessary to draw out the desired amount of paper and cut it off in a single operation. The illustration shows this operation clearly.

Trade Publications □

Architects' Specifications for Carey Building Materials—The Philip Carey Co., Cincinnati, paper, 8½" x 11", illust. This catalog and specification book, which describes Carey products, really consists of seven loose-leaf catalogs. It can be separated and filled as desired. Roofing, expansion joint fillers, waterproofing and insulating materials are described. The several folders are collected in a unique and attractive binder. In addition to information concerning the various products, specification clauses are included for convenient reference.

Park Forms Best for Cement Steps—H. L. Park Co., Reading, Mass., folder, 4" x 7", 10 pp., illust. This attractive piece of trade literature describes a simple set of forms for making concrete steps of all kinds. A unique edger that insures a perfectly straight edge has also been developed.

The Mixer That Makes Money for the Contractor—Chain Belt Co., Milwaukee, folder, 6" x 7½", two colors, illust. This is a well designed and attractive folder describing the Rex 6 and the Rex 10 mixer.

The Little Wonder Scaffold Hoist—Eclipse Scaffolding Co., Omaha, Nebr., paper, 6" x 9", 32 pp., illust. This catalog describes in detail a new type of scaffold hoist which has many advantages. Diagrams make clear not only the operation of the hoist but also the proper arrangement and design of staging.

Hayward Buckets — Pamphlet 609—The Hayward Co., N. Y. C., paper, 6" x 9", two colors, 8 pp., illust. An attractive bulletin, showing the use of Hayward buckets in handling concrete materials. The special adaptability of the bucket to this kind of work is strikingly shown by the illustrations.

Par-Lock—Mastic Bond Co., N. Y. C., paper, 8½" x 11", 4 pp., illust. This folder describes the methods used in applying a waterproof coating and embedding in it gravel in such a way as to form a perfect plaster surface.

Where to Buy Granito—White Stone Marble Co., Atlanta, Ga., folder, 4" x 8½", 4 pp. This folder presents the advantages of whitestone marble for terrazzo and concrete products.

A Mountain of Barrett Specification Roofs—The Barrett Mfg. Co., N. Y. C., folder, 10½" x 13", 8 pp., 2 colors. This is an exceptional piece of advertising matter and illustrates in a combination picture 60 prominent buildings, all of which have been roofed with Barrett products—a convincing piece of advertising literature.

Little Giant Punches and Shears—Little Giant Punch & Shear Co., Sparta, Ill., paper, 5½" x 8", 20 pp., illust. An attractive booklet illustrating and describing the Little Giant line of punches and shears for bars and sheet steel.

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[2] Richard Wilcox Co., Aurora, Ill.

[3] Cavicchi Polishing Machinery Co., Quincy, Mass.

[1] Kolesch & Co., N. Y. C.

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